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TELEMETRY SPECTRUM ANALYZER

MODEL TA-121L

LINEAR SCANNING

11 CPS - 120 KC

PROBESCOPE

211 ROBBINS LANE, SYOSSET, L.I., NEW YORK

INSTRUCTION MANUAL

TELEMETRY SPECTRUM ANALYZER

MODEL TA-121L

LINEAR SCANNING

11 CPS - 120 KC

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SECTION I

INTRODUCTION

1-1. SCOPE OF MANUAL

1-2. This manual contains instructions for the installation, operation and maintenance of the Probescope Spectrum Analyzer, Model TA-121L. The Model TA-121L is designed and manufactured by Probescope Co., Inc., Syosset, Long Island, New York.

1-3. PURPOSE OF EQUIPMENT

1-4. The Spectrum Analyzer, Model TA-121L is a precision instrument for presenting the spectral display of signal energy in the frequency range from 11 cps to 120 kc. The spectral display appears on the screen of a long-persistence cathode ray tube with the frequency of the applied signal being displayed on the horizontal axis, while the amplitude of the signal is displayed on the vertical axis. Some of the specific uses of the Model TA-121L are:

a. Harmonic and distortion study of amplifiers, modulators and oscillators.
b. Noise and vibration analysis.
c. Medical research such as heartbeat and brain wave analysis.
d. Acoustic measurements.
e. Filter and transmission line checks.
f. Assembly line checking and maintenance of equipment.
g. Power supply ripple and harmonic investigations.
h. Underwater sound analysis.

1-5. GENERAL DESCRIPTION

1-6. The Probescope Model TA-121L is a versatile precision instrument which combines high accuracy, simplicity of operation, ease of maintenance, and portability. The Model TA-121L is a highly sensitive superheterodyne receiver, whose voltage output can be linearly or logarithmically displayed on a calibrated cathode ray tube. The equipment consists essentially of a calibrated input attenuator, a low pass filter, a phase inverter, a balanced mixer, a swept local oscillator, crystal filter, i-f amplifiers, a detector, a blocking oscillator (sweep generator), and horizontal and vertical deflection amplifiers for the cathode ray tube display. The Model TA-121L is furnished in a cabinet for bench or cart use, or can be removed from its cabinet for standard rack mounting.

1-7. The Model TA-121L can be used with a companion Spectrum Analyzer, Model TA-100L for the monitoring,analysis and calibration of Telemetering signals from 350 cps to 120 kc. The entire frequency band may be viewed on a logarithmic frequency base (Model TA-100L) and a small portion of this band can be simultaneously displayed on a second cathode ray tube (Model TA-121L). The searching marker (built-in) relates the selected channel displayed to the panoramic display of the entire frequency band.

SECTION I

INTRODUCTION

1-1. SCOPE OF MANUAL

1-2. This manual contains instructions for the installation, operation and maintenance of the Probescope Spectrum Analyzer, Model TA-12ZIL. The Model TA-12ZIL is designed and manufactured by Probescope Co., Inc., Syosset, Long Island, New York.

1-3. PURPOSE OF EQUIPMENT

1-4. The Spectrum Analyzer, Model TA-12ZIL is a precision instrument for presenting the spectral display of signal energy in the frequency range from 11 cps to 120 kc. The spectral display appears on the screen of a long-persistence cathode ray tube with the frequency of the applied signal being displayed on the horizontal axis, while the amplitude of the signal is displayed on the vertical axis. Some of the specific uses of the Model TA-12ZIL are:

a. Harmonic and distortion study of amplifiers, modulators and oscillators.
b. Noise and vibration analysis.
c. Medical research such as heartbeat and brain wave analysis.
d. Accurate measurements.
e. Filter and attenuation line checks.
f. Assembly line checking and maintenance of equipment.
g. Power supply ripple and hum content investigations.
h. Underwater sound analysis.

1-5. GENERAL DESCRIPTION

1-6. The Probescope Model TA-12ZIL is a versatile precision instrument which combines high accuracy, simplicity of operation, ease of maintenance, and portability. The Model TA-12ZIL is a highly sensitive superheterodyne receiver, whose voltage output can be linearly or logarithmically displayed on a calibrated cathode ray tube. The equipment consists essentially of a calibrated input attenuator, a low pass filter, a mixer, a balanced mixer, a swept local oscillator, crystal filter, i-f amplifier, a detector, a blocking oscillator (sweep generator), and horizontal and vertical deflection amplifiers for the cathode ray tube display. The Model TA-12ZIL is furnished in a cabinet for bench or cart use, or can be removed from its cabinet for standard rack mounting.

1-7. The Model TA-12ZIL can be used with a companion Spectrum Analyzer, Model TA-100C, for the monitoring, analysis and calibration of Television signals from 30 cps to 120 kc. The entire frequency band may be viewed on a long-persistence cathode ray tube (Model TA-100C) and a small portion of this band can be simultaneously displayed on a second cathode ray tube (Model TA-12ZIL). The sweep width (built-in) relative the selected channel displayed to the panoramic display of the entire frequency band.

1-8. EQUIPMENT SUPPLIED.

1-9. Table 1-1 lists the equipment which comprises the Model TA-121L

Component	Model or Part No.	Over-All Dimensions (in.)	Weight (lbs.)
Spectrum Analyzer	TA-121L	12¼H. x 19W. x 18D.	55
Line Voltage Regulator		7½H. x 4½W. x 8-3/4"D.	15
Alignment			
Spare Fuses			
Accessory Plug			
Handbook			

Table 1-1. Equipment Supplied.

1-10. TECHNICAL CHARACTERISTICS.

1-11. The technical characteristics of the Model TA-121L are listed below.

Frequency Range	11 cps to 120 kc
Sweep Width (Deviation)	100 cps to 22 kc
Sweep Rate	1 second ±10%
Sweep Width Accuracy	±5% of total deviation
Resolution (automatically optimized)	22 cps to 300 cps*
Voltage Range (full scale deflection)	500 microvolts to 500 volts MRS**
Voltage Scale	RMS and 40 DB Log
Dynamic Range	60 db
Voltage Accuracy	±10% linear scale (rms) ±1 db log scale
Input Impedance	50,000 ohms
External Marker Requirements	5 volts rms
Internal Markers	100 kc (crystal oscillator)
Hum Suppression	60 db
Frequency Stability:	
Short term	20 cps
Long term	500 cps/day
Spectral Display	Signal amplitude on vertical axis (linear or log) versus frequency on horizontal axis.
Cathode Ray Tube	5ADP7 (long-persistence) with edge lighting and camera mount bezel.

*See figure 1-2 for resolution versus sweep width chart.

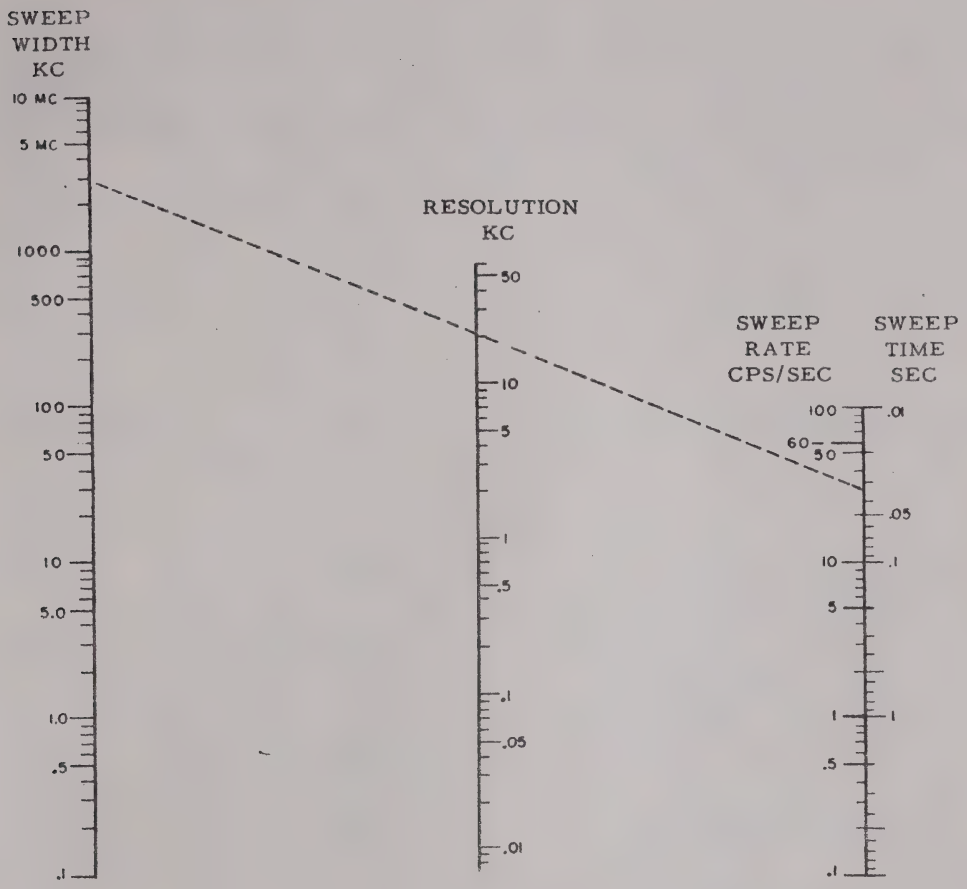
**Overload protection circuit provided.

Signal Outputs:

Vertical	0.5 volts negative pulse minimum
Horizontal	0.5 volts positive sawtooth minimum
Sync	5 volts positive pulse minimum
Local Oscillator	225 to 345 kc signal, 0.5 volts peak-to-peak minimum
Power Requirements	105 to 125 volts ac., 60 cps signle phase, 150 watts. (230 volts ac provided for on request)

1-12. ELECTRON TUBE, INDICATOR LAMP, DIODE, AND FUSE COMPLEMENTS

1-13. Tables 1-3 through 1-6 list the electron tube and indicator lamp, diode and fuse complements respectively.



NOTE

Portions of this nomograph which are usable for the analyzer covered by this Instruction Manual are listed under maximum sweep width, sweep rates and resolution in section I – ELECTRICAL CHARACTERISTICS.

Figure I –2. Resolution Nomograph.

Reference Symbol Designation	Type	Function
V101	NE 2 Neon Bulb	Overload Protection
V103	12AY7	Input Filter
V104	5879	Phase Inverter
V105, V106	6BH6	Balanced Mixers
V107	6AB4	Cathode Follower
V201, V202	6AB4	Crystal Filter Amplifiers
V203, V204, V205	12AU6	I-f Amplifiers
V206	604	Detector
V301	12AU7	A: Blocking Oscillator B: Cathode Follower
V302	6072	A: Swept Oscillator Control B: Swept Oscillator Driver
V303	85A2/5651	Voltage Regulator
V304	12AX7	Horizontal Deflection Amplifier
V305	12AX7	Vertical Deflection Amplifier
V306	6AB4	Marker Oscillator
V401	6201	A: Miller Reactance Tube B: Oscillator
V402	12AT7	A: Oscillator Amplifier B: Cathode Follower
V505	6AS7G	Voltage Regulator Control

Table 1-3. Electron Tube and Indicator Lamp Complement
(Sheet 1 of 2)

Reference Symbol Designation	Type	Function
V506	12AU6	Voltage Control DC Amplifier
V507	85A2/5651	Voltage Regulator
V508	OB2	Voltage Regulator
V509 thru V514	NE 2 Neon Bulb	Defective Filament Indicator
V515 thru V520	#47 Panel Lamps	CRT Edge Lighting
V521	5ADP7	Cathode Ray Tube

Table 1-3. Electron Tube & Indicator Lamp Complement
(Sheet 2 of 2)

Reference Symbol Designation	Type	Function
CR451	Zener Diode 1N2979	Voltage Regulator
CR502,CR503	Syntron SS 95HP	Rectifiers, High Voltage
CR504 thru CR516	Sylvania SR 3011	Rectifiers

Table 1-4. Diode Complement

Reference Symbol Designation	Type	Function
Q450	2N404	Crystal Oscillator
Q451	2N404	Mixer Amplifier
Q452	2N404	Emitter Follower
Q453	2N404	Local Osc. Amplifier

Table 1-5. Transistor Complement

Reference Symbol Designation	Type	Rating
F501,F502	3AG	2A, 250V

Table 1-6. Fuse Complement

SECTION II

INSTALLATION AND OPERATION

2-1. UNPACKING AND PRELIMINARY INSPECTION

2-2. Unpack equipment from its carrying case, observing normal cautions for a precision instrument. Before operating the Model TA-121L, inspect for possible damage during shipment. Check that the equipment is complete as listed in table 1-1 or against the packing slip. After the equipment has been checked for completeness, inspect it as follows:

a. Examine handles and latches for tightness.
b. Operate all front panel controls which should turn freely, be tight on their shafts, and lack of binding.
c. All tubes, crystals, and other plug-in parts are well seated in their sockets.

2-3. INSTALLATION

2-4. The equipment can be placed in any suitable working area where normal lighting and ventilation are present. The line voltage regulator supplied must be used at all times with the Model TA-121L in order to have a stable supply of power to the equipment. The line voltage regulator should be placed as far as possible from the analyzer to minimize hum pickup.

2-5. The Model TA-121L is furnished mounted in a cabinet for bench or cart use. It can be removed from its cabinet for standard rack mounting. Figures 2-1 and 2-2 are outline drawings of the Spectrum Analyzer and Line Voltage Regulator to assist the operator in planning the equipments' installation.

2-6. CONTROLS, INDICATOR, AND CONNECTORS

2-7. The operating controls, indicator, and connectors located on the front panel of the equipment are listed in table 2-1 and shown in Figure 2-3. It is important to know the function of each control before operating the equipment.

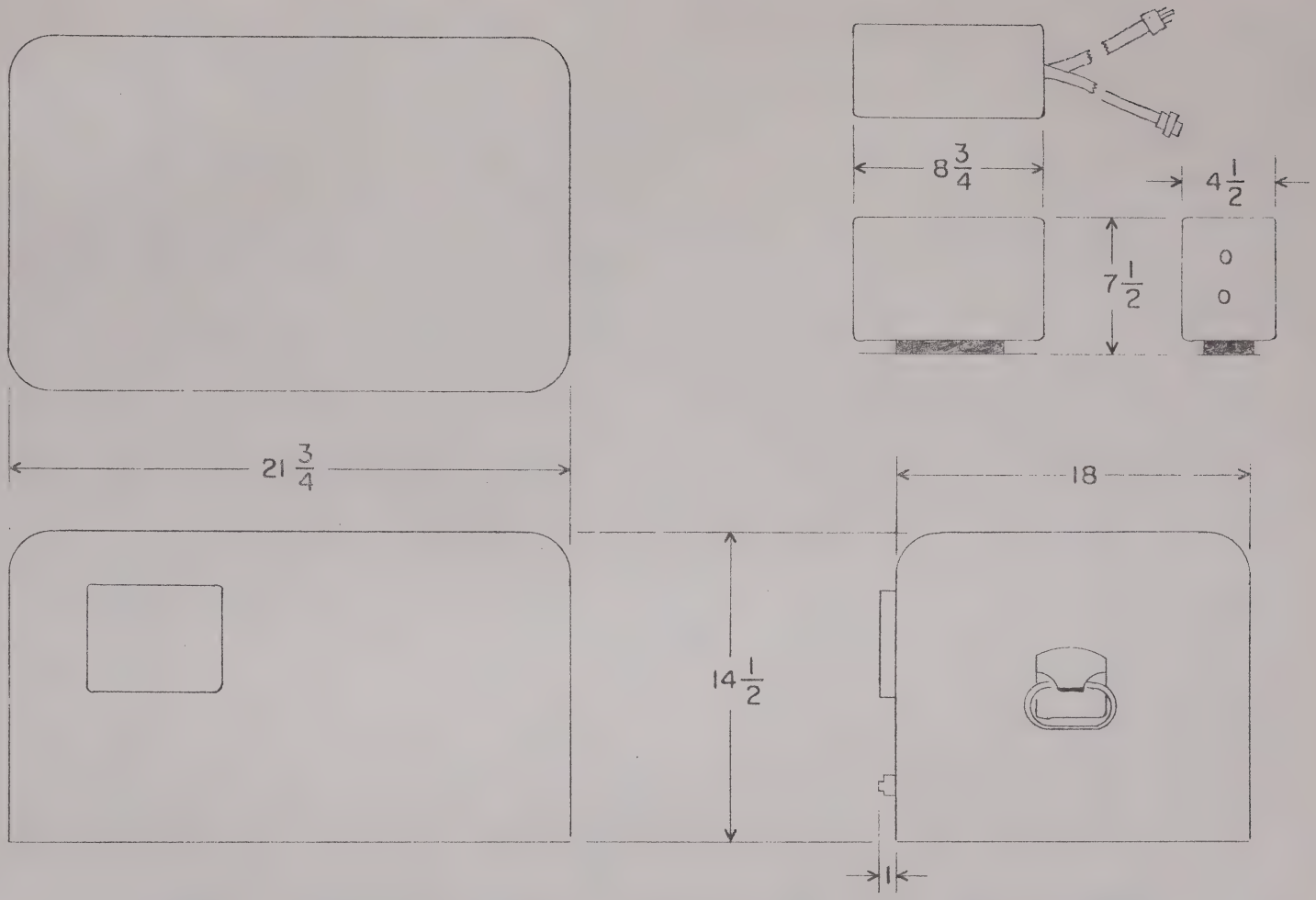


FIGURE 2-1 SPECTRUM ANALYZER MODEL TA-121L AND LINE REGULATOR OUTLINE DRAWING

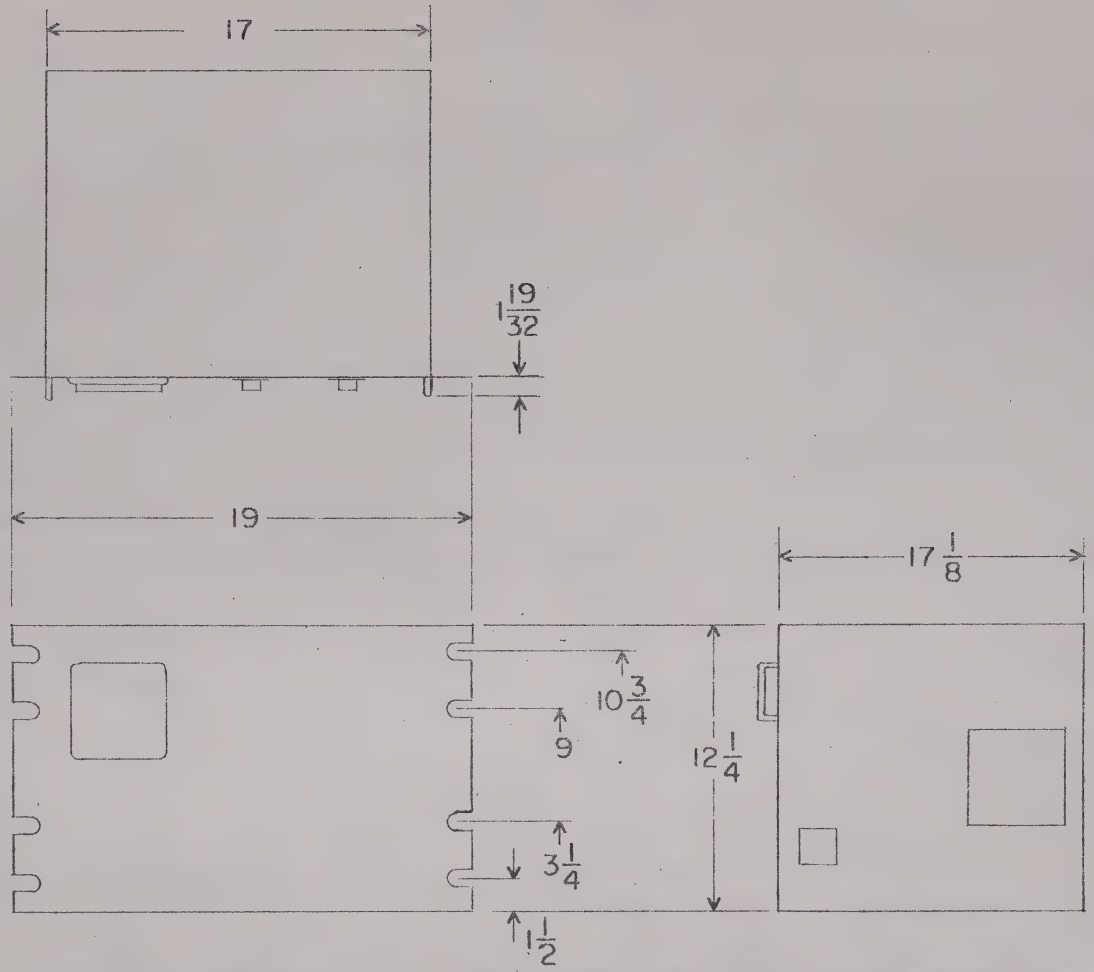


FIGURE 2-2 SPECTRUM ANALYZER MODEL TA-121L RACK MOUNT DRAWING

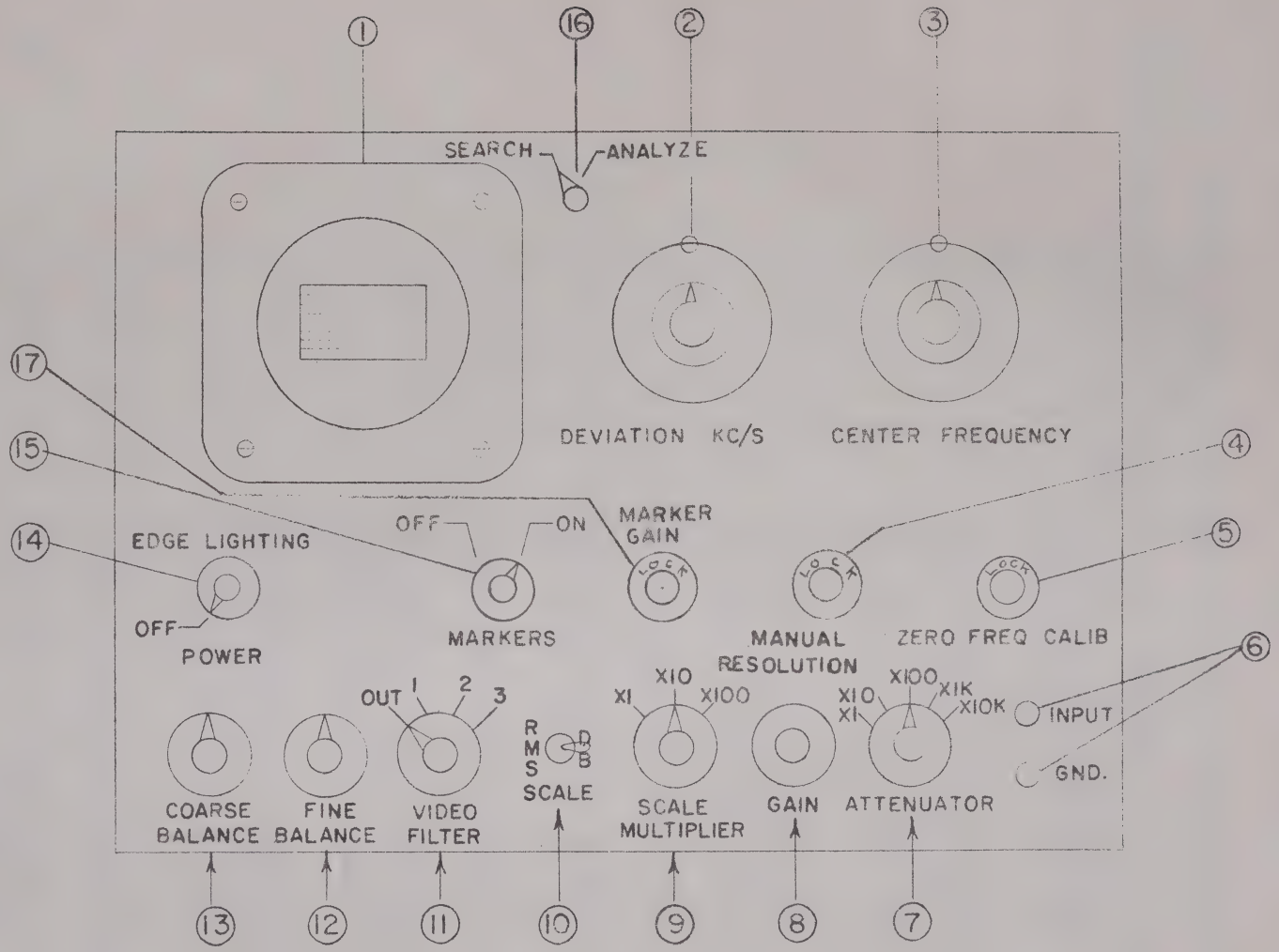


FIGURE 2-3. OPERATING CONTROLS, INDICATORS AND CONNECTORS

Figure 2-3 Index No.	Front Panel Designation	Function
1	CATHODE RAY TUBE	Provides input signal display; frequency on horizontal axis, amplitude (linear or log) on vertical axis.
2	DEVIATION KC/S	This control varies the sweep width (between 100 to 22,000 cps) of the portion of the spectrum to be analyzed. It is automatically tracked for optimum resolution at any deviation setting.
3	CENTER FREQ.	This control is individually calibrated for each Model TA-121L at 2.5 kc intervals from 0 to 120 kc. It indicates the frequency at the center of the screen.
4	MANUAL RESOLUTION	A fine adjustment of the resolution (at minimum deviation).
5	ZERO FREQ. CALIB.	This control is used to adjust the horizontal position of the zero-frequency pip.
6	INPUT/GND	Input signals to be analyzed are applied to these terminals.
7	ATTENUATOR	A calibrated voltage divider for reducing the level of the input signal. This control is used to vary the amplitude of signal on the signal.
8	GAIN	Permits adjustment of the height of the vertical display on the crt screen. Calibrated sensitivity holds only when this control is set fully clockwise.
9	SCALE MULTIPLIER	This calibrated three-position control further attenuates the incoming signal.
10	SCALE	This switch permits choice of vertical screen calibration: (on next page)

Table 2-1. Operating Controls, Indicator, and Connectors
(Sheet 1 of 2)

Figure 2-3 Index No.	Front Panel Designation	Function
10 (cont'd)	SCALE (cont'd)	RMS - Horizontal lines on screen indicate linear rms amplitude as calibrated along left edge. DB - Dots appearing along right edge indicate 5 db increments from 20 to -20 db as calibrated.
11	VIDEO FILTER	The VIDEO FILTER control is used to eliminate beat interference between two adjacent signals. Proper choice of filter position is indicated by no change in amplitude. Position 3 is used in noise and vibration analysis. It provides an average reading of the noise appearing on the screen.
12,13	FINE BALANCE COARSE BALANCE	These controls are used to suppress the zero-frequency beat frequency on the screen.
14	POWER	This control energizes the equipment and varies the crt edge lighting.
15	MARKERS	This switch (in the ON position) applies an internally generated crystal-controlled 100 kc marker.
16	SEARCH/ANALYZER	The SEARCH position is used when the equipment is used with the Model TA-100L. The analyzer setting is used for detailed analysis of signals. The Searching Marker is automatically turned on and is available at the rear apron output jack when in the search position.
17	SEARCH MARKER GAIN	This control adjusts the amplitude of the Marker signal.

Table 2-1. Operating Controls, Indicator, and Connectors (Sheet 2 of 2)

2-8. OPERATION

2-9. PRELIMINARY OPERATING PROCEDURE. The procedure given below is to be followed prior to making measurements with the Model TA-121L:

(1) Connect a nominal 115 volts AC, 60 cps, single phase power source to the equipment thru the line voltage regulator.

(2) Set the front panel controls to:

CENTER FREQUENCY	-	0
SEARCH/ANALYZER	-	Analyzer
DEVIATION KC/S	-	10
SCALE MULTIPLIER	-	X100
SCALE	-	DB
GAIN CONTROL	-	Maximum Clockwise

(3) Turn the POWER control clockwise until the crt screen is illuminated to desired brightness.

(4) Within a few seconds a dot will appear and begin moving across the screen. This dot is the baseline trace.

(5) A zero-frequency pip will soon appear on the screen. Allow at least 30 minutes for the pip drift to stabilize.

NOTE

If the zero-frequency pip is not visible on the screen, reduce the attenuation setting of the SCALE MULTIPLIER control to X10 or X1. If the pip is still not visible or is extremely small, set SCALE switch to RMS.

(6) If the zero-frequency pip is not directly at the center graticule of the screen, unlock and adjust the ZERO FREQ. CALIB. control to position the pip. Relock this control.

(7) Set CENTER FREQUENCY control to 100 kc.

(8) Set MARKERS switch to ON.

(9) A marker pip will appear at the center graticule of the screen.

(10) The equipment is now ready for use.

NOTE

The signal presentation adjustment controls have been factory set for optimum viewing. If it is required to adjust the signal presentation, refer to paragraph 2-10 for the procedure.

2-10. PRESENTATION ADJUSTMENT

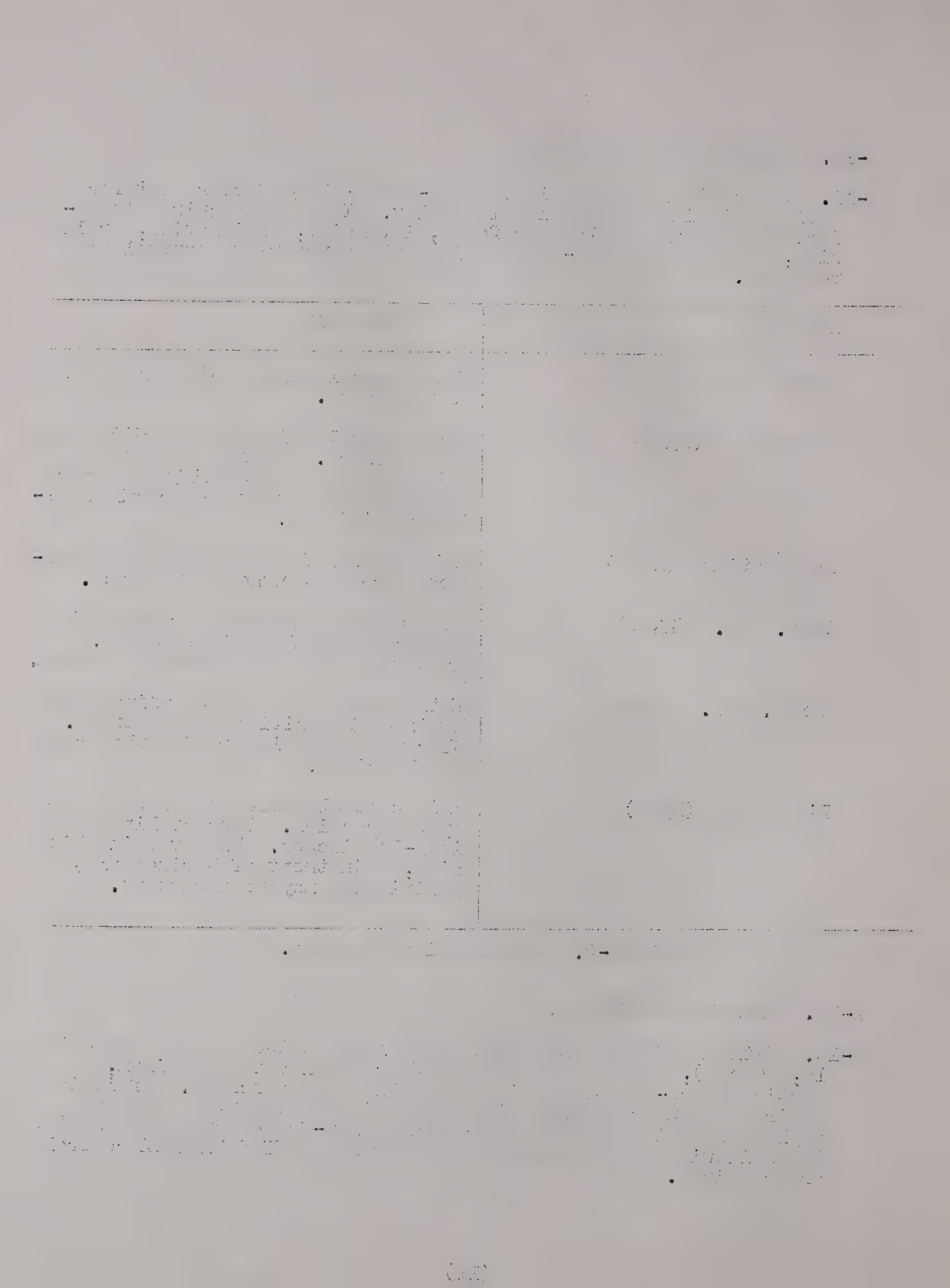
2-11. The controls listed in table 2-2 have been factory set for optimum viewing of the signal display. If it is required to adjust the signal display for focus, intensity, astigmatism, or line size, refer to table 2-2 and adjust the appropriate control as required.

CONTROL	FUNCTION
Focus (R520)	This control adjusts the sharpness of the trace.
Intensity (R517)	This control adjusts the brilliance of the trace. (Note: Do not use this control to intensify the trace because of excessive external lighting conditions).
Astigmatism (R522)	This control is used to provide uniform focus throughout the trace.
Vert. Pos. (R337)	This control is used to adjust the vertical position of the trace. Clockwise rotation raises the trace.
Horiz. Pos. (R327)	This control is used to adjust the horizontal position of the trace. Clockwise rotation shifts the trace to the right.
Line Size (R322)	This control varies the size of the spot excursion. Correct line size is 3-3/4 inches. When varying line size, adjustment of horizontal positioning may be necessary.

Table 2-2. Presentation Controls.

2-12. BALANCE ADJUSTMENT.

2-13. With the CENTER FREQUENCY control set between 0 and 10 (0 to 10,000 cps), and the DEVIATION KC/S control set to maximum, a vertical zero-frequency pip is visible on the screen. If it is desired to suppress this pip because it may interfere with an applied signal display or when making low-frequency measurements, the following adjustments of the COARSE and FINE BALANCE controls are required.



(1) Set the front panel controls to:

SCALE MULTIPLIER - X100

SCALE - DB

DEVIATION KC/S - Maximum

(2) If the zero-frequency pip is not visible on the screen, reduce the attenuation setting of the SCALE MULTIPLIER control to X10 or X1. If the pip is still not visible or too small to observe reduction when rotating the COARSE and FINE BALANCE controls, set the SCALE switch to RMS.

(3) Slowly rotate the COARSE BALANCE control for maximum suppression of the zero-frequency pip.

(4) Slowly rotate the FINE BALANCE control in very small increments for further suppression of the pip. Adjustment of this control is very critical.

(5) Several back-and-forth adjustments of these two controls may be necessary until the balance is completed.

2-14. MANUAL RESOLUTION ADJUSTMENT

2-15. During noise and vibration analysis measurements, it may be desired to adjust the resolution of the spectral display (e.g. where equivalent noise bandwidth is desired). Unlock ajd adjust the MANUAL RESOLUTION control for the desired bandwidth.

Follow the procedure given below to reset the MANUAL RESOLUTION control.

(1) Set front panel controls to:

Center Frequency	-	50
Video Filter	-	off
Deviation KC/S	-	maximum
Scale	-	RMS
Attenuator	-	X10
Scale Multiplier	-	X10
Search/Analyzer	-	Analyzer

(2) Apply a 50 kc signal to the INPUT/GND terminals of the equipment.
(3) Adjust 50 kc signal output level for full scale deflection on crt.
(4) Set deviation KC/S to minimum.
(5) Adjust MANUAL RESOLUTION control for full scale signal deflection.

(6) Repeat steps (3), (4), and (5) until no interaction between controls is observed.

(7) Rotate deviation KC/S control from minimum to maximum and note that signal pip amplitude does not vary more than 2 boxes. If improper, repeat steps (3) thru (6) until proper response is obtained.

2-16. SCALE MULTIPLIER AND ATTENUATION CONTROLS ADJUSTMENT

2-17. Five nominal input voltage ranges are provided to attenuate signal to the Model TA-121L. Each of these ranges is divided into three scale ranges by the SCALE MULTIPLIER control. Table 2-3 lists the rms voltage required for full-scale signal deflection with any combination of the SCALE MULTIPLIER AND ATTENUATOR controls. Absolute voltage measurements of any incoming signal (up to 500 volts rms) can be read directly from the screen. Calibration only holds when the GAIN control is set fully clockwise.

ATTENUATOR / SCALE MULTIPLIER	X1	X10	X100	X1K	X10K
X1	.5mv	5mv	.05v	.5v	5v
X10	5mv	.05v	.5v	5v	50v
X100*	.05v	.5v	5v	50v	500v

*RMS voltage of applied signal should never exceed amount indicated in this row.

Table 2-3. RMS Voltage Required for Full-Scale Deflection.

2-18. SPECTRAL DISPLAY MEASUREMENTS

2-19. To observe the spectral characteristics of signals for: Frequency component identifications; harmonic investigations; modulation characteristics; power supply filtering; etc., the following general techniques should be used:

(1) Follow the procedure given in paragraph 2-9, for starting up the equipment.

(2) If the input voltage level of the signal to be analyzed is unknown, set the ATTENUATOR control to X10K and the SCALE MULTIPLIER control to X100. If the input voltage level is known, refer to paragraph 2-16 for appropriate settings of the ATTENUATOR and SCALE MULTIPLIER controls.

(3) Connect the signal to be analyzed to the front panel INPUT/GND receptacles.

NOTE

Providing that the voltages indicated in table 2-3 are not exceeded, it is completely permissable to have crt screen deflections greater than full scale, thereby permitting measurements of low-level sideband signals and amplitude ratios as great as 60 db.

(4) Set the CENTER FREQUENCY control the the frequency of the applied signal and the DEVIATION KC/S control to maximum. If the frequency of the applied signal is unknown, rotate the CENTER FREQUENCY control until the signal is displayed on the crt. Reduction of the attenuation settings of the ATTENUATOR and SCALE MULTIPLIER controls may be required if the signal is not visible or too small in amplitude.

(5) Set the DEVIATION KC/S control for desired spectrum width.

(6) When performing frequency measurements, set the SCALE switch to RMS to obtain a better definition of the signal pip(s) Direct frequency measurements can be performed by either of two methods:

a. Rotate the CENTER FREQUENCY control until the signal of interest is directly over the center graticule of the crt screen. The frequency of the signal can be read directly from the CENTER FREQUENCY control markings.

b. For frequency identification of complex signal spectrums, the setting of the DEVIATION KC/S control, and relating the spectrum width to the horizontal reference base line percentage graduations, the frequency of the signal of interest can be read.

EXAMPLE: Assume that the CENTER FREQUENCY control is set to 10 (10,000 cps), and the DEVIATION KC/S control is set to 1 (1,000 cps). This arrangement permits signals from 9,000 to 11,000 cps to be displayed on the screen. The bottom graduations are marked in percentage of deviation from the center of the screen. Therefore, in this illustration, each 20% marking inidcates 200 cps either below or above 10,000 cps. If a signal is observed directly at the -40% marking, this signal is at a frequency of:

10,000 cps - 400 cps = 9,600 cps

(7) A 100 kc crystal-controlled marker signal is available when the MARKERS switch is in the ON position. This marker pip can be used to determine frequency of applied signals and for checking dial accuracy.

2-20. VOLTAGE MEASUREMENTS

2-21. Absolute voltage measurements of signal(s) or the voltage

difference between adjacent signals may be measured in the following manner:

(1) Follow the procedure given in paragraph 2-9.

(2) If the input voltage level of the signal to be measured is unknown, set the ATTENUATOR control to X10K and the SCALE MULTIPLIER control to X100. If the input voltage level is approximately known, refer to paragraph 2-16 for appropriate settings of the ATTENUATOR and SCALE MULTIPLIER controls.

(3) Connect the signal to be measured to the INPUT/GND receptacles.

(4) Set the CENTER FREQUENCY control to the frequency of the applied signal. If the frequency of the applied signal is unknown, rotate the CENTER FREQUENCY control until the signal is displayed on the crt. Reduction of the attenuation settings of the ATTENUATOR and SCALE MULTIPLIER controls may be required if the signal is not visible or too small in amplitude. Set the DEVIATION KC/S control for desired spectrum width.

(5) To observe signals of comparable amplitude, the SCALE switch should be set to RMS. The RMS scale of the crt screen is calibrated into ten divisions. Horizontal line on the crt screen indicate linear rms amplitude. When simultaneous examination of signals of side divergence (greater than 20 db but less than 40 db) of amplitude is desired, the DB setting of the SCALE switch permits both signals to be seen. In this position, the calibrated range is from 20 db to -20 db in 5 db divisions as indicated by dots appearing along the right side of the crt. screen.

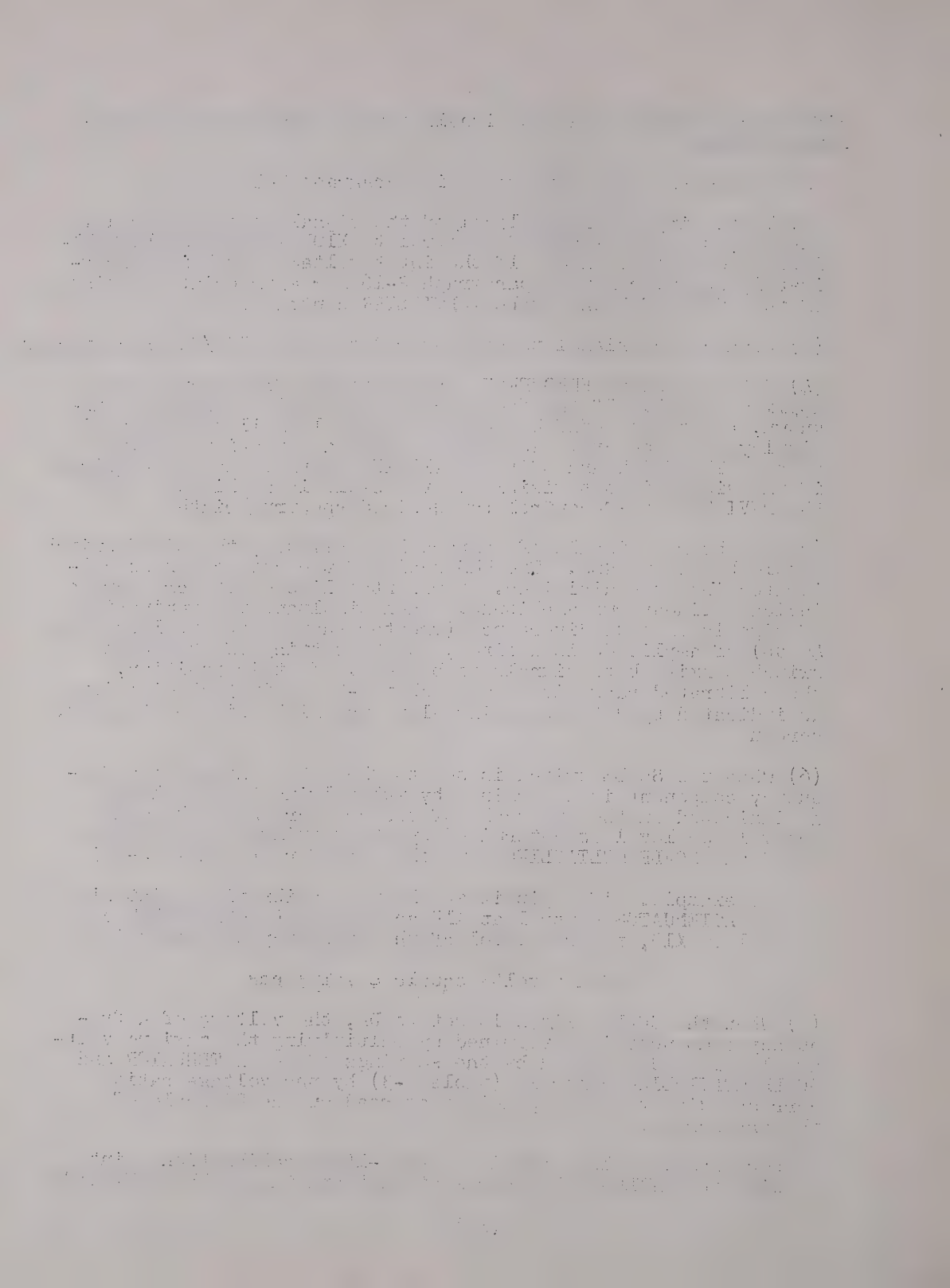
(6) When the SCALE switch is set to RMS, the voltage of a frequency component is determined by multiplying the pip height as indicated on the rms scale of the crt screen by the maximum voltage level as determined by the settings of the ATTENUATOR and SCALE MULTIPLIER controls. (Refer to table 2-3.)

For example: If a pip is at the 0.8 calibration point with the ATTENUATOR control at X1K and the SCALE MULTIPLIER control at X10, the rms level of the frequency component is:

0.8 x 5 volts equals 4 volts rms

(7) When the SCALE switch is set to DB, the voltage of a frequency component is determined by multiplying the maximum voltage level as determined by the settings of the ATTENUATOR and SCALE MULTIPLIER controls (table 2-3) by the voltage ratio corresponding to the pip height as read on the DB scale of the crt screen.

For example: If a pip is at the -15 DB calibration point with the ATTENUATOR control at X10K and the SCALE MULTIPLIER



control at X10, the rms level of the frequency component is:

a. -15 db corresponds to a voltage ratio of 0.178 (refer to table 2-4.)

b. 0.178 x 50 volts equals 8.90 volts rms

(8) If a noise is present (beats between adjacent signals), making measurements difficult, proper setting of the VIDEO FILTER control is required. The proper choice of filter position is indicated by no change in pip amplitude.

2-22. NOISE MEASUREMENTS.

2-23. In performing noise measurements, the same general techniques are used for setting the equipment as in spectral display measurements. (Refer to paragraph 2-18). Additional front panel controls may be used as described below:

(1) To obtain good smoothing of the noise content, the broadest resolution is desired. Set DEVIATION KC/S control to minimum. Unlock and rotate the MANUAL RESOLUTION control for desired bandwidth. (Refer to paragraph 2-14.)

(2) In noise analysis, video filtering can be used to obtain smoothing of the noise spectrum envelope. Position 3 of the VIDEO FILTER control is provided for this purpose.

(3) Amplitude calibration for random signals are obtained on the Model TA-121L by use of an external calibrated noise generator. By comparing the relative amplitude of a random signal (noise) with that of a known random signal on the Model TA-121L precise measurements and analyses can be performed.

2-24. SEARCHING MARKER

2-25. In using the Searching Marker, all control functions are located on the front panel. The equipment operation with the Searching Marker is as follows:

a. Connect coaxial cable from "Marker Out" jack of TA-121L (rear apron) to the "Marker In" jack of the TA-100L (rear apron).

b. Turn power switch to "ON" Position.

c. Analyzer/search position of TA-121L in "search" position.

d. Set desired level of marker on TA-100L with "Search Marker Gain" control, located on TA-121L front panel.

e. Turn "CF" control on TA-121L until marker zero beats with signal which is to be analyzed as viewed on the TA-100L.

f. Change analyzer-search position of TA-121L to "analyze" position. The equipment is now ready to analyze the marked signal.

SECTION III

THEORY OF OPERATION

3-1. INTRODUCTION

3-2. The Model TA-121L is a superheterodyne receiver whose detected output is displayed on a cathode ray tube. It cover the frequency range from 1 cps to 120 kc. The Model TA-121L displays the frequency of the applied signal along the horizontal axis while the amplitude of the signal is displayed linearly or logarithmically on the vertical axis. This section of the manual discusses the theory of operation for the Model TA-121L. It is divided into two parts--a simplified block diagram analysis, and a detailed circuit analysis.

3-3. SIMPLIFIED BLOCK DIAGRAM ANALYSIS.

(See Figure 3-1.)

3-4. The simplified block diagram shows only the basic elements that are necessary to explain the operation of the spectrum analyzer. The following description traces a signal through this simplified network.

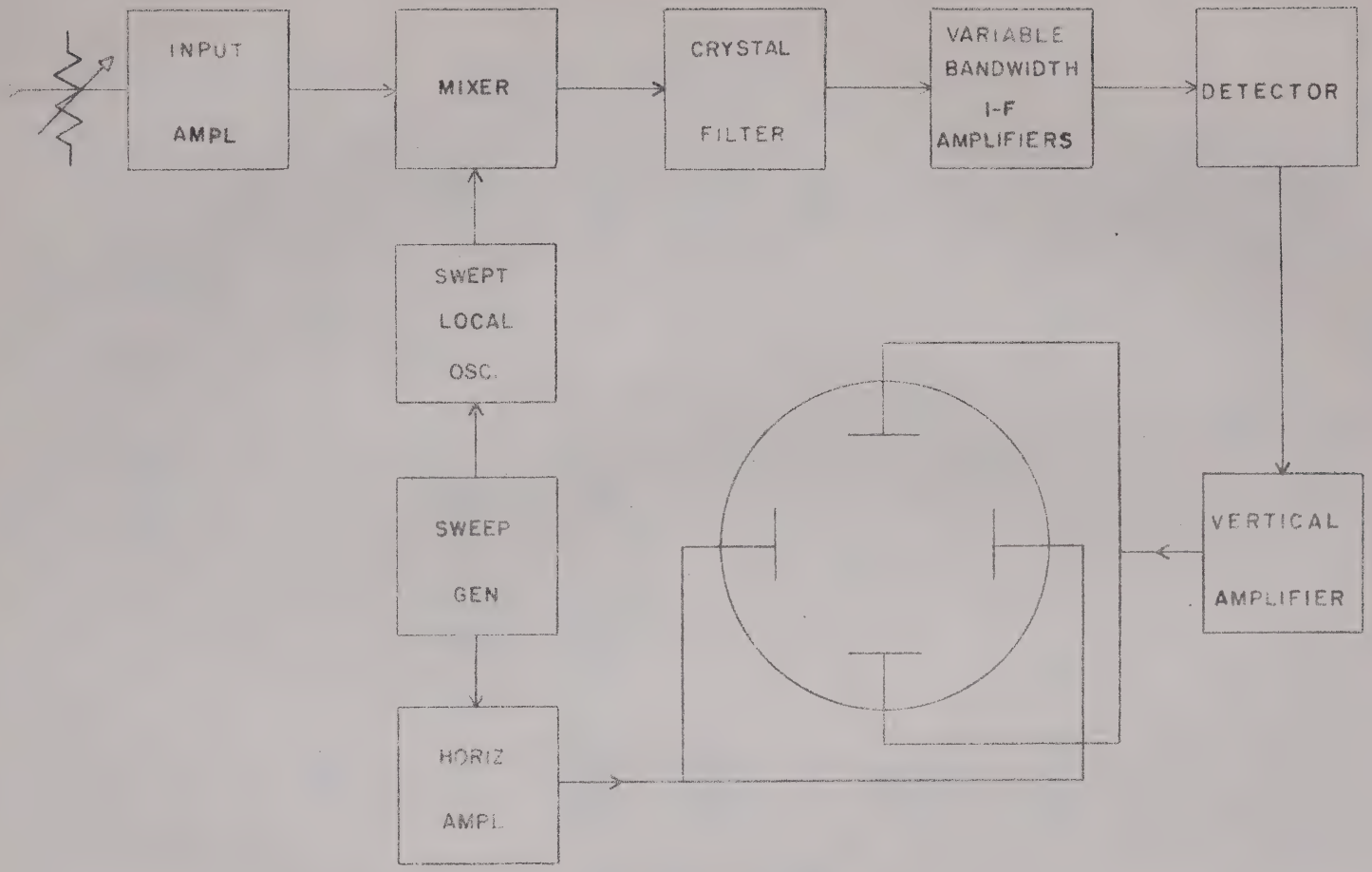
3-5. A signal applied to the Model TA-121L can be attenuated and then amplified to a suitable level. It is then mixed with a swept local oscillator signal always 225 kc above the frequency of the incoming signal. The resultant 225 kc i-f difference frequency output is then filtered, amplified, and detected. The detected signal is further amplified to drive the vertical deflection plates of a cathode ray tube. At the same time, a synchronizing sawtooth signal which sweeps the local oscillator also is applied to the horizontal deflection plates of the cathode ray tube, so that movement of the spot across the screen is proportional to the swept local socillator frequency.

3-6. DETAILED CIRCUIT ANALYSIS

(See Figure 3-2.)

3-7. The circuit stages shown in figure 3-2 essentially comprise the Model TA-121L Spectrum Analyzer. The following paragraphs detail the operation of each stage. (Refer to both the block diagram, figure 3-2, and the schematic, figure 4-3.)

3-8. ATTENUATOR AND OVERLOAD PROTECTION CIRCUIT. All input signals are applied through an attenuator circuit (R101 through R108) which permits a choice of five input ranges. This circuit is a calibrated voltage divider permitting incoming signals as large as 500 volts rms to be displayed on the cathode ray tube. A neon lamp V101 acts as a voltage regulator to prevent damage to the equipment if excessive voltage is applied to the Spectrum Analyzer.



FIGUR 3-1 SIMPLIFED BLOCK DIAGRAM

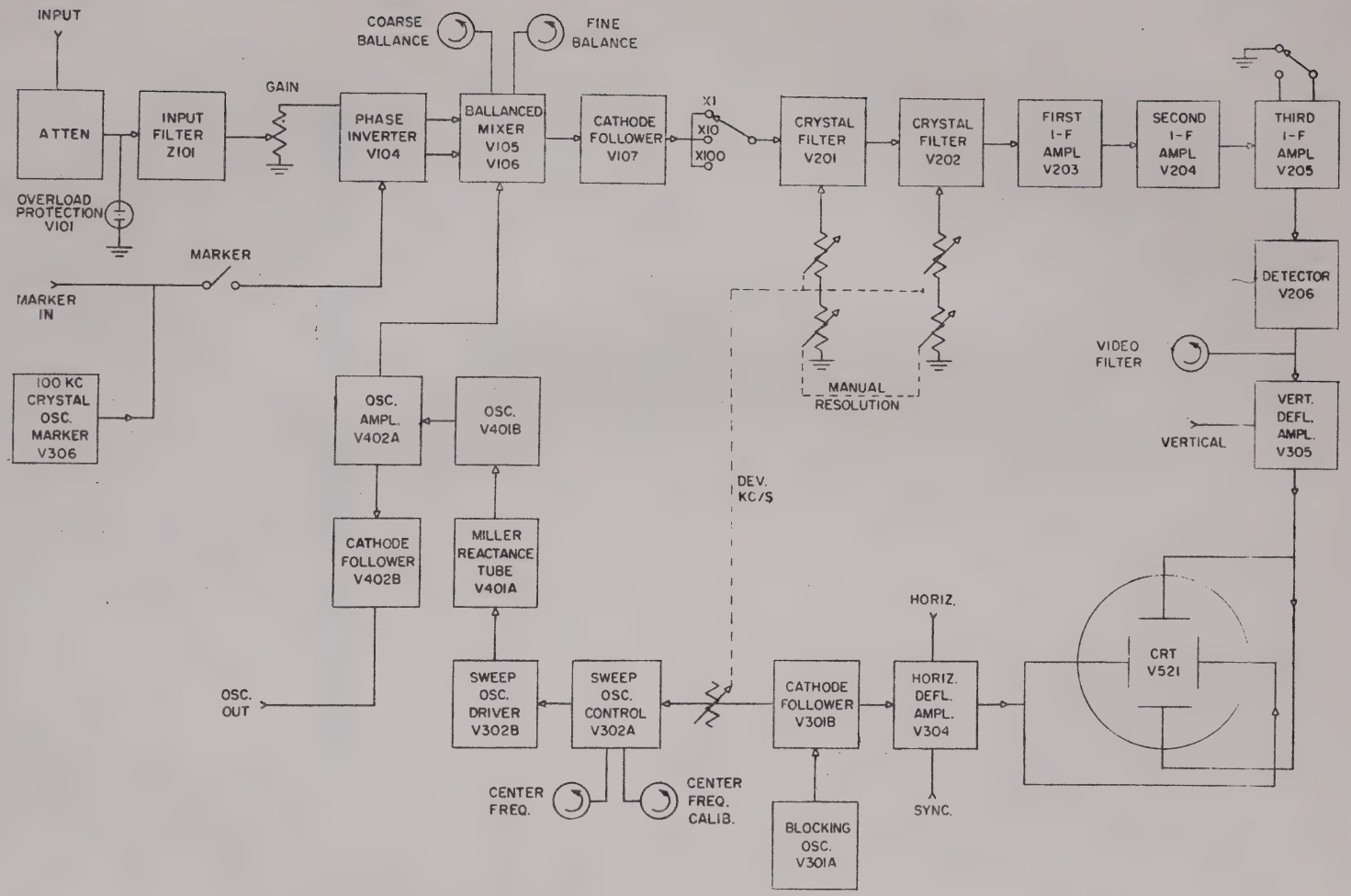


FIGURE 3-2 DETAILED BLOCK DIAGRAM

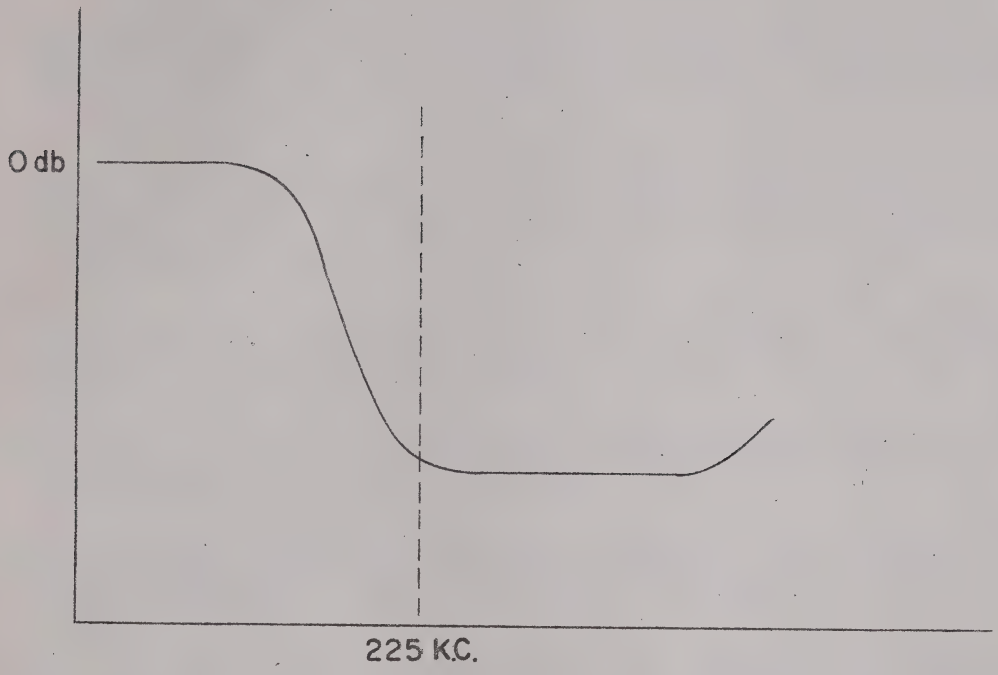


FIGURE 3-3 FILTER BANDPASS CHARACTERISTIC

3-9. INPUT FILTER V103. The input filter V103 serves to reject spurious signals at or above the i-f frequency (225 kc) from being displayed on the cathode ray tube. This circuit is a notch filter with a bandpass characteristic as shown in figure 3-3. The output of the filter is applied to phase inverter V104.

3-10. PHASE INVERTER V104. The output of filter V103 is applied through capacitor C104 and GAIN control R114 to the grid of phase inverter V104. Tube V104 produces two outputs (one at the plate and one from the cathode) 180 degrees out-of-phase with each other.

3-11. The GAIN control adjusts the displayed amplitude of the signal. When rotated fully clockwise (maximum gain), absolute voltage measurements can be made of the displayed signal. Harmonic balance potentiometer R119 is used to cancel out any harmonic components in tube V104.

3-12. For frequency calibration purposes, a 100 kc marker signal from tube V306 can be applied to the control grid of tube V106. External markers can be also applied to tube V106, via jack J305 (with MARKERS switch in the ON position).

3-13. The plate output of tube V104 is coupled to the grid of balanced mixer V105, while the cathode output of tube V104 is coupled to the grid of balanced mixer V106.

3-14. BALANCED MIXERS V105 AND V106. Tubes V105 and V106 are used to beat the swept local oscillator signal with the incoming signal and apply the resultant difference frequency to the i-f circuit.

3-15. The swept local oscillator signal is applied to the cathodes of V105 and V106. Since the plate currents of V105 and V106 due to the swept local oscillator signal are in-phase, the difference of potential across the plate tank Z102 is zero and the swept local oscillator signal does not appear at the output. However, the input signal is applied to the grid circuits of V105 and V106 180 degrees out-of-phase with each other and will beat with the local oscillator signal in the plate circuits. The difference frequency will appear across Z102.

3-16. BALANCE controls R132 and R138 are used to set the proper screen voltage of V105 and V106, and correct the impedance in the plate circuit which suppresses the local oscillator carrier. Capacitor C107 and resistor R121 insure correct impedance in the grid circuit for best balance. The secondary of the plate circuit Z102 applies the 225 kc i-f signal to cathode follower V107.

3-17. CATHODE FOLLOWER V107. Tube V107 provides a low impedance source for the 225 kc i-f signal to the i-f amplifier stages. It also acts to isolate the gain calibrate control R201 and SCALE

MULTIPLIER control S201 to crystal filter driver V201. Control R201 varies the amplitude of the i-f signal fed to the IF amplifiers to adjust for full scale deflection of signal pip to maintain amplitude calibration of the equipment.

3-19. CRYSTAL FILTER DRIVES V201 and V202. The output of tube V107 is applied by one of three positions of SCALE MULTIPLIER control S201 to the grid of the first crystal filter driver V201. The selectivity of the Spectrum Analyzer is regulated by varying the bandwidth of the two 225 kc crystal filters Y201 and Y202 which insures optimum resolution at all sweep widths.

3-20. The signal input from the cathode of V201 is fed through capacitor C203 and the 225 kc crystal filter Y201 to the grid of the second crystal driven filter amplifier V202. Simultaneously, the output from the plate of V201 (amplified i-f signal) is coupled through neutralizing capacitor C202 (to neutralize crystal holder capacity) to the grid of tube V202. A load tank circuit L201, C204, and R212 acts as a resistance in series with crystal Y201 to control the crystal filter bandwidth. Resolution controls R210 and R211 are across the tank circuit and vary the series resistance and bandwidth. R210 is geared with the DEVIATION control to insure optimum resolution for all deviation settings. The MANUAL RESOLUTION control can produce a small variation of resolution for noise and vibration investigation at minimum deviation settings.

3-21. Tube V202 performs in an identical manner as tube V201. Its output from the plate is coupled to the grid of the first i-f amplifier V203.

3-22. I-F AMPLIFIERS V203, V204, AND V205. The output of the second crystal driven filter amplifier V202 is applied to the grid of the first i-f amplifier V203. The signal is amplified and applied to the grid of second i-f amplifier V204 through i-f transformer Z201. The second i-f amplifier V204 also amplifies this signal; however, the amplification of this stage is tracked to the resolution and deviation controls. Gain tracking control R226 is automatically adjusted for minimum resistance when the DEVIATION control is tuned to minimum deviation with a resultant constant over-all gain for all bandwidth settings. Gain compensation control R225 sets the proper amplification range over which the gain tracking control will operate.

3-23. The output of the second i-f amplifier V204 is coupled through the second i-f transformer Z202 to the grid of the third i-f amplifier V205. The third i-f amplifier V205 has two modes of operation. In the SCALE-RMS position, V205 acts as a linear amplifier; in the DB position, V205 has an amplification curve that approximates a log characteristic.

3-24. When the SCALE switch S202 is in the RMS position, the grid of V204 is grounded through the secondary of transformer Z202

and resistor R232. This causes V205 to amplify the i-f signal in a linear manner.

3-25. With the SCALE switch in the DB position, a portion of the detected signal from tube V206 is applied through R243, filtering network R242, C228, R232, and C219, to the grid of V205. At the same time, the screen voltage of V205 is changed to a value required for proper gain characteristics. Controls R243 and R241 are set to shape the logarithmic output of V205. The output of V205 is coupled through the third i-f transformer Z203 to the cathode of detector V206.

3-26. DETECTOR V206. The output of the third i-f amplifier stage is applied to the cathode of detector V206. Here the i-f signal is rectified and filtered. Voltage divider R237 and R238 in tank circuit Z203 applies a small positive voltage to the cathode of V206 to insure a more linear operation.

3-27. When a signal is fed to the cathode of V206, current flows only during the negative half of the input cycle. The rectified i-f output at the plate of V206 is filtered by R243 and C227. This rectified output signal follows the peaks of the i-f frequency. These peaks approximate the bandpass characteristics of the i-f crystal filters.

3-28. The rectified output signal is applied through voltage divider R244 and R245 and an additional high frequency filter R246 and C304 to the grid of the vertical deflection amplifier V305.

3-29. VERTICAL DEFLECTION AMPLIFIER V305. The rectified signal output of V206 is applied to the grid of V205 for amplification to drive the vertical deflection plates of the cathode ray tube. The input signal of V305 can be filtered (via VIDEO FILTER control S301) by capacitors C304, C305, C306, or C307, which act as a lowpass filter to eliminate high frequency signals and beat interference.

3-30. The output of detector V206 applies a negative signal pulse the the grid of V305A. Negative voltage is applied to the grid of V305B, through voltage divider R338 and R337. Vertical position control R337 adjusts the negative voltage on V305B. This change of voltage on the grid of V305B changes the plate potential with a resultant change of vertical position on the cathode ray tube.

3-31. LOCAL OSCILLATOR V401 AND V402. Tube V401 serves as the local oscillator, in that, it provides a signal between 225 to 345 kc to heterodyne with the incoming signal. Tube V402 amplifies and couples the local oscillator signal to balanced mixers V105 and V106 and also makes the local oscillator signal available as a signal source for external equipments.

3-32. Dual triode V401 functions as a Miller reactance tube (A section) and as a Hartley oscillator (B section). The Miller reactance tube V401A varies the oscillator frequency from 225 to 345 kc. This tube is essentially an electronically varying capacitor across tank circuit Z401 with the frequency variation being controlled by the center frequency dc voltage and deviation ac sweep. Tube V401B maintains its oscillations through tank circuit Z401 and applies its output to the grid of tube V402A.

3-33. The amplified signal from tube V402A is fed to the cathodes of balanced mixers and to the grid of cathode follower V402B. The cathode of tube V402A is tied to ground which limits the signal swing with a nearly constant amplitude output.

3-34. The signal from the cathode follower V402B is fed to the OSC. OUT jack to provide a signal source for external equipments such as the Probescope Model SG-20 Synchronous Sweep Generator.

3-35. BLOCKING OSCILLATOR V301. The blocking oscillator provides a timing reference voltage (sawtooth) for the horizontal deflection amplifier V304 and the sweep circuit V302. This sawtooth voltage has a fixed repetition rate of one sweep every second by R301.

3-36. The voltage at the terminal of capacitor C302 and resistor R305 is a linear sawtooth and is applied through a voltage divider consisting of resistors R304 through R307. Resistor R305 acts as a maximum sweep width adjustment since variation of this control varies the amplitude of the sawtooth applied to sweep oscillator circuit V302. The junction of resistors R306 and R307 feeds the sawtooth to the horizontal deflection amplifier V304.

3-37. SWEPT OSCILLATOR CONTROL V302. The Swept Oscillator Control regulates the sawtooth from tube V301 for controlling the frequency and sweep (deviation) of the local oscillator signal.

3-38. Sawtooth voltage is coupled from Pin 8, V301 through I521, R314 and R308 to point A, as shown in Fig. 3-4. R308 is adjusted for zero average voltage of the sawtooth at point A. I521 is used to provide a d.c. voltage drop without affecting the amplitude waveshape of the sawtooth signal.

3-39. The d.c. voltage at point D is controlled by the position of the arm of the CENTER FREQ. control, R318. Since the valves of R601 and R602 are equal and the valves of R319 and R320 are also equal, the d.c. difference of potential between points B and C is effectively zero and any variations of resistance in R305, R309, and R313 will not effect the d.c. voltage appearing at Pin 7 of V302B. Therefore, this d.c. voltage will vary with the center frequency control and will be approximately one half of the voltage appearing at point D. The deviation control, R312, will control the amplitude of the sawtooth superimposed upon

this d.c. voltage at Pin 7 of V302B.

3-40. This composite signal is applied to the Swept Local Oscillator from the cathode of V302B. The d.c. level determines the center frequency of the oscillator and the sawtooth amplitude determines the sweep width.

3-41. HORIZONTAL DEFLECTION AMPLIFIER V304. Tube V304 is a twin-triode amplifier functioning as a cathode-coupled, push-pull balanced amplifier. The use of a balanced amplifier insures proper linearity and minimum distortion of the horizontal sweep voltage.

3-42. The sawtooth is fed from a voltage divider in the cathode circuit of tube V301B to line size control R322. Adjustment of this control results in a change in magnitude of the sawtooth to the grid of V304A. Tube V304A acts as an amplifier, while tube V304B acts as an inverter and amplifier to produce a signal of the same amplitude but of opposite polarity at the plate of the tube V304A. The sawtooth output of V304A and V304B is applied to the horizontal deflection plates of the cathode ray tube.

3-43. Horizontal positioning of the trace is effected by means of potentiometer R327 and line size by means of R322. The sawtooth at the cathodes of V304 is made available at the horizontal output jack J301 through resistor R331. The sawtooth output from V304B is differentiated by C308, R332, and R333 to provide a sync pulse at the sync jack J302.

3-44. MARKER OSCILLATOR V306. Tube V306 is used to generate a 100 kc marker for calibrating a signal displayed on the cathode ray tube. The marker oscillator is a Pierce oscillator, utilizing a 100 kc crystal Y301. The crystal-controlled marker signal from the grid of V306 is fed through isolation filter C313 and R342 to the MARKERS switch. R343 and C314 isolate an external marker from tube V306. The 100 kc signal is applied to the grid of V106 when the MARKERS switch is in the ON position.

3-45. CATHODE RAY TUBE V521. Tube V521 is a long-persistence cathode ray tube and by use of an orange filter it gives a bright yellow trace without any notable halo. The cathode ray tube operates with approximately 2,100 volts of accelerating potential. A negative 800 volts is applied to the filament and control grid and to the cathode through intesity control R517. A negative voltage is also applied to the first anode through voltage divider R519 and focus control R520. A positive voltage is applied to the third anode from the junction of R501 and C502.

3-46. In order to insure proper focus on the face of the cathode ray tube, the second anode is kept at roughly the same dc potential as the horizontal and vertical deflection plates. This is accomplished by dividing a portion of the B+ supply through

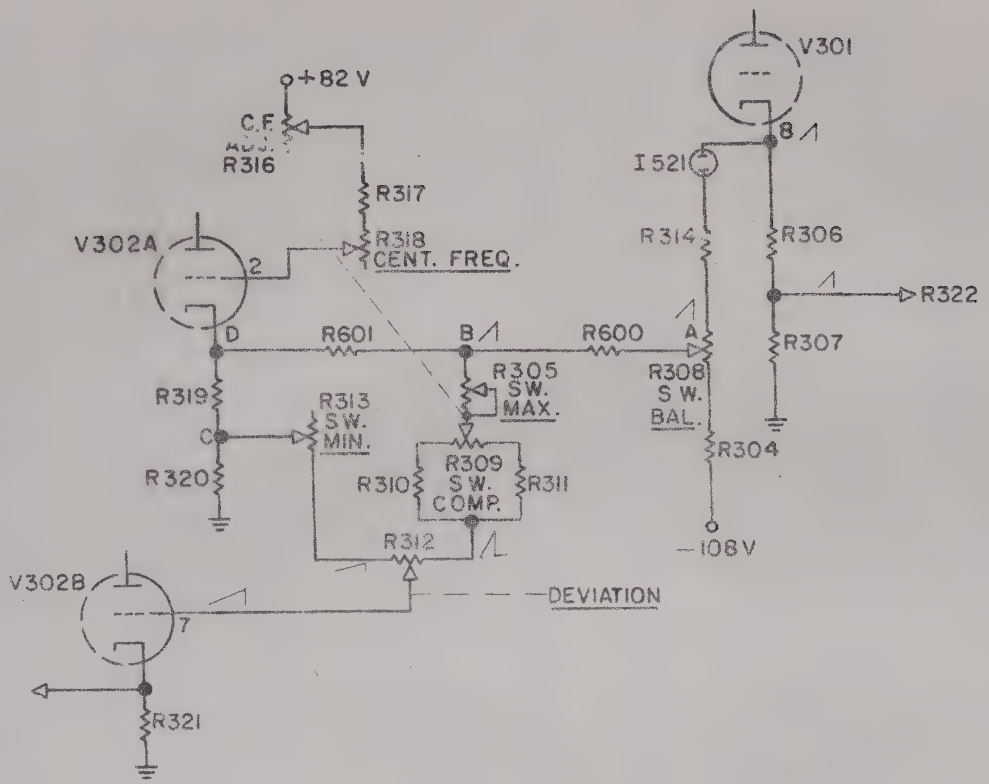


FIGURE SWEPT OSCILLATOR CONTROL

the astigmatism control R522 to the second anode.

3-47. POWER SUPPLIES. (See Figure 3-5.) The Model TA-121L power supply consists of six separate supplies.

1. +1300 volts dc crt supply
2. -800 volts dc crt supply
3. -105 volts dc B- supply
4. +101 volts dc filament supply
5. +270 volts dc B+ supply
6. 6.3 volts ac supply

3-48. CATHODE RAY TUBE POWER SUPPLY. For the high-voltage low-current requirements of the cathode ray tube, a diode rectifying circuit is employed to produce the crt power supply. The output voltage appearing across the secondary of transformer T502 is tapped and applied to high voltage diodes CR502 and CR503. The output of this network, which produces the 1300 and -800 volts dc required, is applied to the various accelerating and control grids of the cathode ray tube.

3-49. Discharge resistors R502 and R535 are provided across the positive 1300 volts dc supply as a means to discharge the high-voltage when power is disconnected.

3-50. Filter network R501 and C502, and C501, and C503 reduce the ac ripple content of the high voltage supply to a minimum.

3-51. B- SUPPLY. A -105 volts dc supply is required for biasing various circuits throughout the equipment. The supply is derived from a secondary tap of transformer T502, which is rectified by diodes CR506, CR505, and CR504. The rectified ac voltage is filtered by R513, C508, and R514 and regulated by voltage regulator tube V508.

3-52. The current that passes through voltage regulator V508 also passes through resistor R515. If the -105 volts dc supply tends to drop, the voltage across V508 tends to drop. However, the gas in tube V508 deionizes slightly and less current passes through this tube. The current in resistor R515 is decreased by the amount of the current decrease in tube V508. Since the current in resistor R515 is less, the voltage drop across resistor R515 is also less and the voltage across the load is held nearly constant.

3-53. B+ SUPPLY. The +270 volts dc supply is a series type degenerative regulator consisting of transformer T502, diodes CR507 through CR512, voltage control tube V505, voltage control dc amplifier tube V506, and voltage regulator tuve V507.

3-54. The ac input is stepped-up by transformer T502 to approximately 450 volts. This voltage is rectified by diode network CR507 through CR512; filtered and applied to the plates of voltage control tube V505. The B+ adjustment control R510 is set

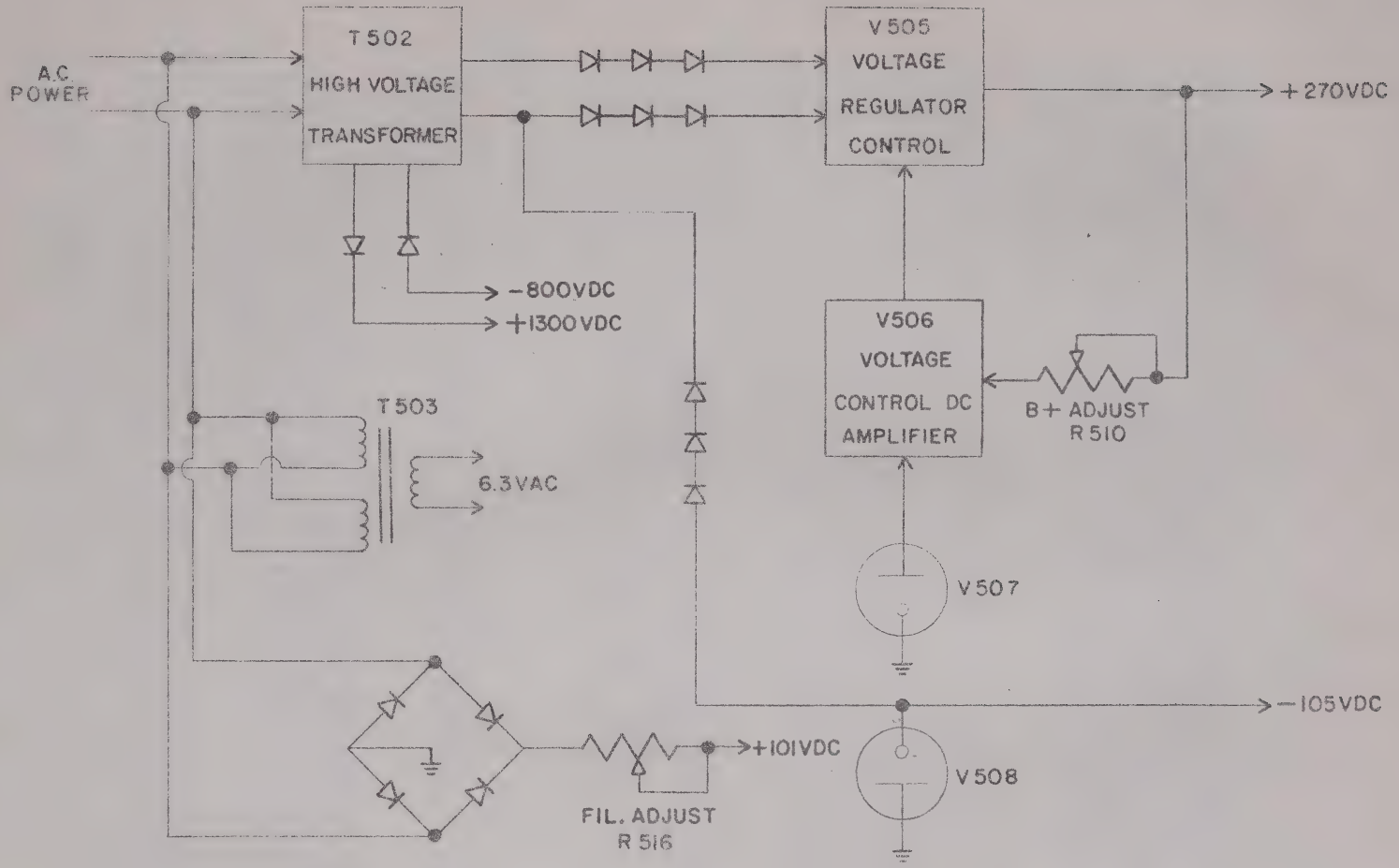


FIGURE 3-4 POWER SUPPLIES SIMPLIFED BLOCK DIAGRAM

to produce an output voltage of +270 volts dc. The setting of R510 determines the value of bias applied to control grid of dc amplifier V506. Any change in the output voltage because of loading or line voltage variations causes a like change in the bias applied to the control grid of V506. Changing the bias of V505 changes its plate resistance, which causes the B+ supply voltage to return to normal. Voltage regulator V507 provides the necessary reference voltage for the operation of dc amplifier V506.

3-55. FILAMENT SUPPLY. The +101 volts dc filament supply is derived from a full-wave rectifier bridge configuration. This supply furnishes the filament voltage for most tubes in the equipment. The input voltage is rectified across balanced bridge rectifier CR513 through CR516. It is adjusted by filament control R516 and filtered by capacitor C509 to keep the filament ripple to a minimum. Neon indicator V509 through V514 are placed across tube sections to indicate open filaments. Filtering capacitor C510 is placed in the filament string to further reduce any ripple present.

3-56. CRT EDGE LIGHTING. A 6.3 volts ac supply is provided to furnish the edge lighting for the cathode ray tube screen. The input voltage is stepped down across transformer T503 and is applied to edge lighting lamps V517 through V520. This supply also provides for the filament of V505, and for the indicator lamps V515 and V516, located above the center frequency and deviation controls.

3-57. SEARCHING MARKER

3-58. BLOCK DIAGRAM DESCRIPTION. (See Figure 3-5). The Searching Marker consists of a crystal oscillator (operating at 225 kc), a mixer-amplifier, and a low-pass filter as shown in the block diagram.

In operation, the crystal oscillator signal mixes with the swept local oscillator signal in the mixer amplifier circuit. The resultant frequencies are applied to the low-pass filter. However, due to the characteristics of the filter, only the difference frequency will pass to the marker level control, and thence to the marker output jack.

3-59. CIRCUIT DESCRIPTION (See Figure 3-6). The Searching Marker consists of a crystal oscillator, a local oscillator amplifier, a mixer, a low-pass filter, and an emitter follower output.

The crystal oscillator consists of Q450. It is a Colpett circuit operation at 225 kc.

Q453 is a common emitter amplifier which amplifies the swept oscillator signal, and feeds it thru C458 and R463 to the base of the mixer Q451. This stage is a grounded emitter mixer-amplifier. The oscillator signal coupled from R463 mixes with the crystal oscillator outputffrom R453 and the resultant sum & difference frequencies appear at the collector. These frequencies are fed to a low-pass filter. Due to the characteristics of the filter, only the difference frequency will pass through.

The signal is then applied to the base of Q452, an emitter follower. The emitter of this stage is connected to the marker level pot R458, at the front panel, and, in turn, to the Searching Marker output jack on the rear apron.

The voltage requirement of the Searching Marker is -15 volts. This is obtained from the -108 supply in the Analyzer. The -108 volts is dropped through R464 and R465, and regulated by CR451 at -15 volts. This voltage is applied to the Searching Marker only when the search-analyze switch is in the search position.

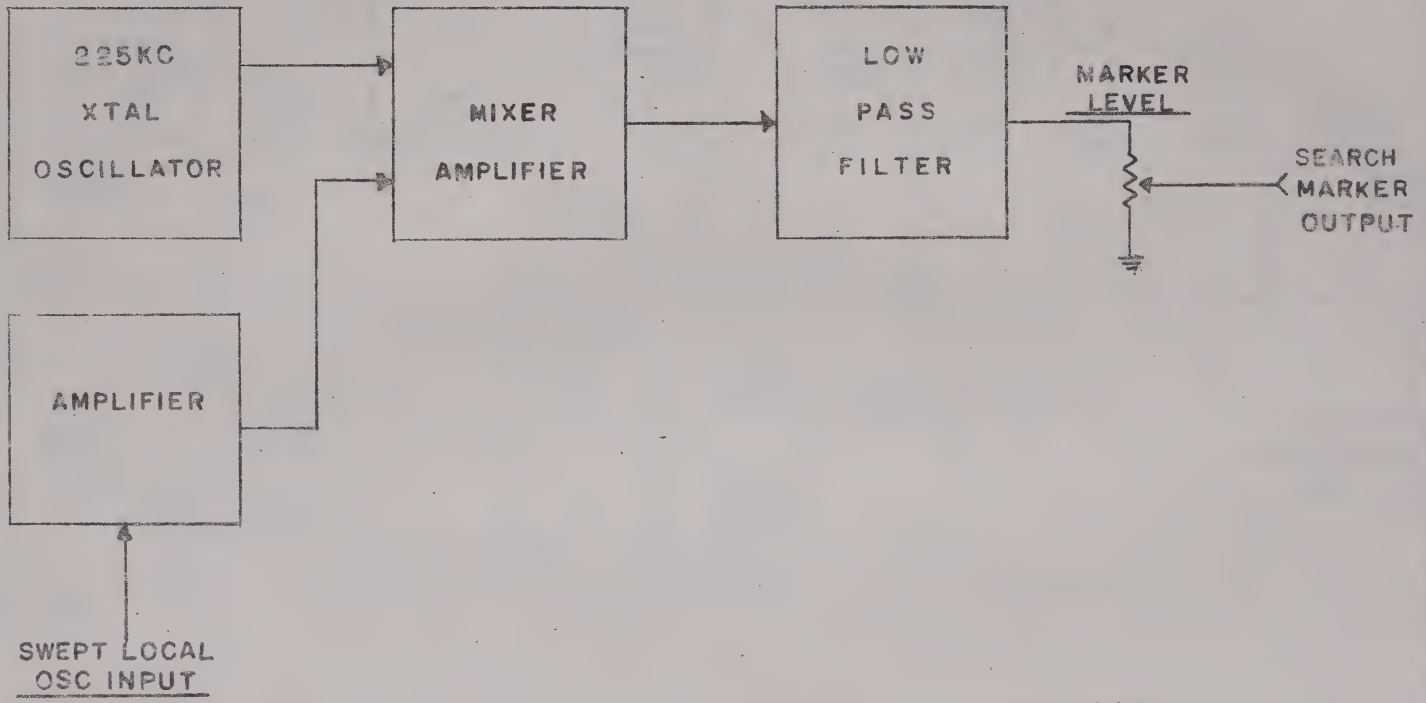


FIG 3-5 BLOCK DIAGRAM

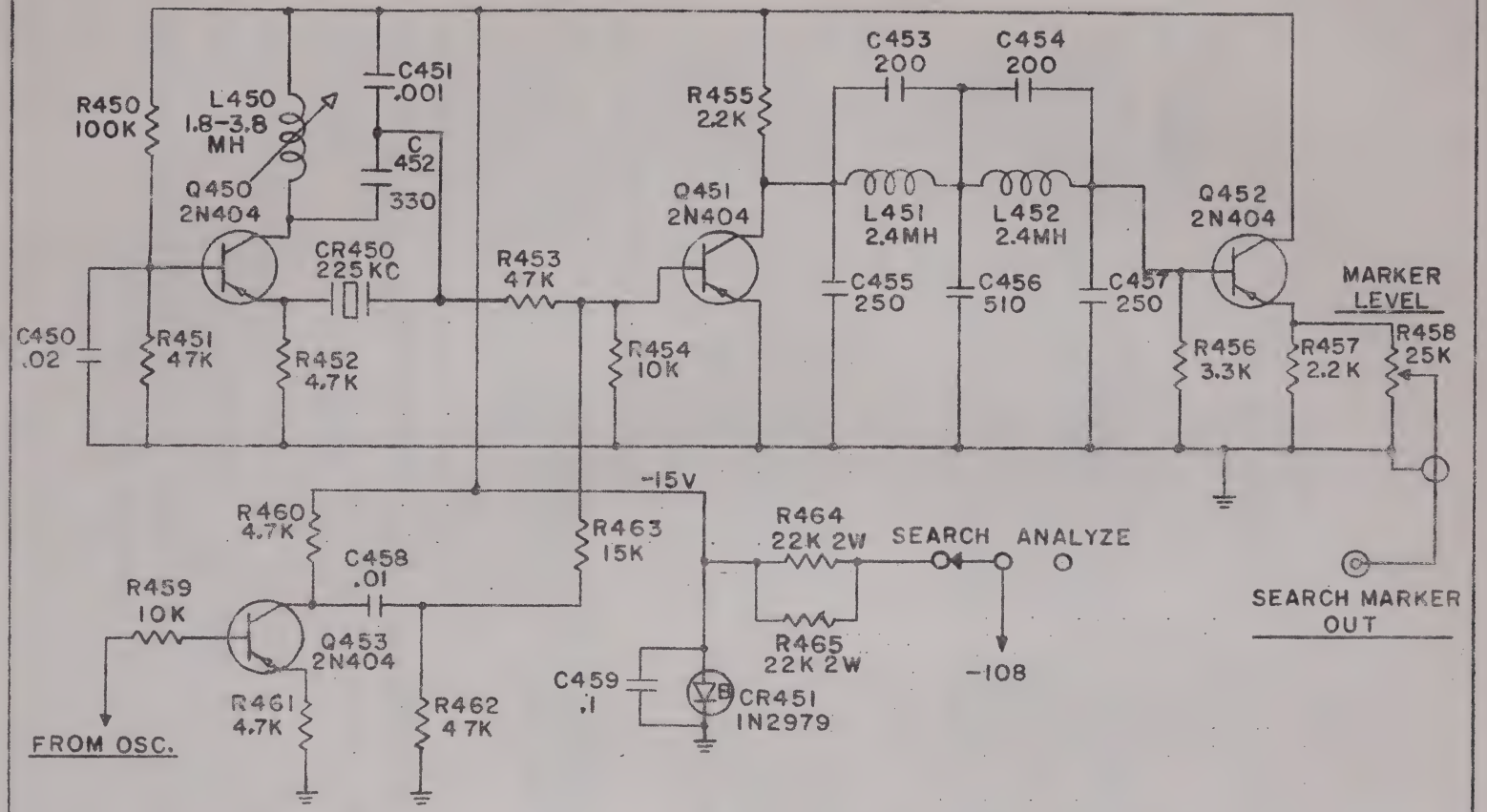


FIG 3-6 SEARCHING MARKER

SECTION IV

MAINTENANCE

4-1. GENERAL

4-2. This section contains procedures to be followed for maintaining the equipment in operating condition. Included are: Test equipment, minimum performance standards, circuit trouble shooting procedures, system trouble shooting procedures, tube replacement touch-up procedure, adjustment and alignment instructions, removal and replacement instructions, schematic, and voltage and resistance charts. It is extremely important that this section of the manual be read thoroughly before performing maintenance procedures.

4-3. TEST EQUIPMENT

4-4. Table 4-1 lists the test equipment required to check-out the operation of the Model TA-121L and to determine the defective circuit or component if the equipment becomes inoperative. Test equipment of equivalent characteristics can be substituted for the suggested test equipment listed in table 4-1. In any event, all test equipment used must be in good operating condition and properly terminated when required.

4-5. MINIMUM PERFORMANCE STANDARDS

4-6. Table 4-2 details the minimum performance standards for the Model TA-121L. The minimum performance standards determine if the equipment is operating satisfactorily upon receipt, repair or long periods of storage.

Test Equipment	Manufacturer	Application
Oscillator	Hewlett-Packard Model #650A	Alignment and Calibration
Oscilloscope	Tektronix Model 543	Observing waveforms
Multimeter	Simpson Model 260	Voltage and Resistance Measurements

Table 4-1. Test Equipment Required

Step	Purpose	Procedure	Normal Indication	Probable Cause if Indication is Abnormal
1	Determine if power is being applied and cathode ray tube edge lighting variation.	Apply a nominal 115 volts ac, single phase 60 cps, power source (thru line voltage regulator) to equipment. Turn POWER control clockwise.	Note crt edge lighting varies with rotation of POWER control Within a short period of time a dot will appear and begin moving across the screen.	Table 4-3, step 1-5.
2	Determine whether crt display is operating.	Set front panel controls to: SCALE--RMS MARKERS--OFF CENTER FREQ.--0 DEVIATION KC/S--10 Allow at least 30 minutes for zero-frequency pip to stabilize.	Zero-frequency pip directly over center graticule.	Refer to paragraph 2-9; if still improper refer to table 4-3, step 8.
		Observe zero frequency pip presentation.	A sharp, proper brilliance, uniform trace positioned properly on screen.	Refer to paragraph 2-10; if still improper, refer to table 4-3, step 8.
		Adjust BALANCE controls (refer to paragraph 2-12) for reduction of zero-frequency pip height.	Pip can be appreciably reduced in height.	Refer to table 4-3, step 8.
		Rotate DEVIATION KC/S control.	Zero-frequency pip widens or becomes narrower depending on rotation.	Refer to table 4-3 step 10.

Figure 4-2. Minimum Performance Standards (Sheet 1 of 2)

Step	Purpose	Procedure	Normal Indication	Probable Cause if Indication is Abnormal
		Set CENTER FREQ. control to 100. Place MARKERS switch to ON.	A marker pip appears at center of screen.	Refer to table 4-3, step 14.
		Set front panel controls to: DEVIATION KC/S--max. CENTER FREQ.--10 SCALE MULTIPLIER--X10 ATTENUATOR--1K GAIN--fully clockwise VIDEO FILTER--OFF Apply a 5-volt, 10 kc calibrated signal to the equipment.	A full-scale signal pattern is displayed directly over center graticule.	Refer to table 4-3, steps 8 & 9.
		Rotate GAIN Control counter-clockwise. Reset GAIN Control fully clockwise.	Signal decreases in height with rotation of control.	GAIN Control defective.
		Set SCALE switch to DB.	Signal height is at 0 db indication on screen.	Refer to table 4-3, step 15.

Figure 4-2. Minimum Performance Standards (Sheet 2 of 2)

WARNING

HIGH VOLTAGES DANGEROUS TO HUMAN LIFE ARE PRESENT IN THE EQUIPMENT. PERSONNEL MUST OBSERVE SAFETY REGULATIONS AT ALL TIMES.

4-7. CIRCUIT TROUBLE SHOOTING PROCEDURES.

4-8. The circuit trouble shooting procedures are listed in table 4-3. This procedure follows the procedures given in table 4-2, the minimum performance standards. The probable causes for the symptoms listed in table 4-3 are given in the order of their probable occurance. The defective component or circuit is located in table 4-3 together with the remedy for correcting the malfunction. In some cases, the defect cannot be attributed to a particular component within the i-f circuit, therefore, reference is made to the i-f circuit troubleshooting table 4-4. Reference is also made to the system trouble shooting procedures, when required.

4-9. If a tube is replaced, refer to table 4-5 for any touch-up procedure required. Always check performance of the particular stage to determine if a touch-up is required.

4-10. As an aid to the maintenance technician, neon indicators V509 through V514 have been placed across most tube filaments in the equipment. If a tube filament becomes open, its associated neon indicator will become illuminated, pin-pointing the defective filament section.

4-11. When trouble shooting a particular tube circuit, always first ascertain that the proper voltages are being supplied to all tube elements. Many questions concerning the condition of a tube in a given circuit can be answered by substituting a tube known to be free from defects in place of questionable tube(s) and comparing the performance of the equipment.

Step	Trouble	Probable Cause	Remedy
1	No power being applied to equipment when POWER control is rotated clockwise.	No ac power input.	1. Check line regulator. 2. Check power cord. 3. Check power connection to equipment.
		Fuse defective.	Check fuses. Replace if defective. Never replace a fuse with one of a higher current rating. If a fuse burns out immediately after replacement, do not replace it a second time until the cause has been determined and trouble has been corrected.
		Power supply component defective.	Refer to paragraph 4-12, and step 1.
2	Screen illumination (edge lighting) is off or does not vary with rotation of POWER control.	Defective POWER control or edge lighting circuitry, V517 V520.	Check continuity of R528, transformer T503, and/or lamps V517 through V520. Replace defective component.
3	Low or no intensity of trace.	Defective high voltage power supply.	Refer to paragraph 4-12, step 1.
		Defective crt.	Replace crt and/or defective associated circuitry.
		Anode cap improperly connected to crt.	Correct connection.
4	Erratic or no trace.	Horizontal or vertical deflection amplifier.	Replace tube V304 or V305 and/or defective associated circuitry.
		B+ or B- power supplies.	Refer to paragraph 4-12, step 1.
		Sweep Circuit.	Refer to paragraph 4-12, step 3.
5	Trace cannot be positioned properly.	Horizontal or vertical deflection amplifiers.	Replace tube V304 or V305 and/or defective associated circuitry.

Table 4-3. Circuit Trouble Shooting Table (Sheet 1)

Step	Trouble	Probable Cause	Remedy
5 (Cont'd)		B+ or B- power supplies.	Refer to paragraph 4-12, step 1.
6	AC hum on baseline.	Defective or improperly positioned crt shield, or electromagnetic pick-up.	Correct as required.
		B+ or B- capacitor filters, C504 thru C508, or C511.	Replace defective component.
7	Intensity modulation on trace.	Electromagnetic pick-up.	Correct as required.
		High voltage filter capacitor C501 or C502.	Replace defective component.
8	Zero-frequency pip, 100 kc marker, and applied signal not displayed on screen.	Local Oscillator	Refer to paragraph 4-12, step 7.
		Balanced Mixer V105 or V106.	Replace defective tube and/or defective associated circuitry.
		I-F Circuit.	Refer to table 4-4.
		Vertical Deflection Amplifier V305.	Replace tube V305 and/or defective associated circuitry.
9	Zero-frequency pip on screen but no input signal pip(s) appears.	Defective ATTENUATOR switch S101.	Replace defective part.
		Input Filter Z101 not seated properly.	Correct as required.
		Defective tube V103 or V104.	Replace defective tube and/or defective associated circuitry.
10	No deviation of signal pip with rotation of DEVIATION KC/S control.	Defective gear train assembly (planetary drive slipping or loose coupling on gear train).	Repair as required.

Table 4-3. Circuit Trouble Shooting Table (Sheet 2)

Step	Trouble	Probable Cause	Remedy
10 (cont'd)		Broken lead on DEVIATION KC/S control.	Correct as required.
11	Input signals do not appear at correct frequency points.	Local Oscillator.	Refer to paragraph 4-12, step 7.
12	Loss in sensitivity.	I-F Circuit.	Refer to table 4-4.
		Local Oscillator.	Refer to paragraph 4-12, step 7.
		Balanced Mixer V105 or V106, or Input Filter Z101.	Replace defective tube and/or defective associated circuitry.
13	Selectivity (resolution improper).	Crystal Filters V201 or V202.	Replace defective tube or crystal Y201 or Y202.
		Defective DEVIATION KC/S gear train assembly.	Repair or replace defective component.
14	No 100 kc marker pip.	Tube V306.	Replace tube V306 and/or defective associated circuitry.
15	Logarithmic amplitude display improper (linear amplitude display correct)	SCALE switch S202 or log shaping circuit.	Replace defective component.
16	Frequency shift with rotation of DEVIATION KC/S control.	Improper setting of S.W. Balance control R308. R600 and R601 not matched. R319 and R320 not matched	Refer to paragraph 4-30. If still improper, replace defective component.

Table 4-3. Circuit Trouble Shooting Table (Sheet 3 of 3)

Step	Trouble	Procedure	Normal Indication	Probable Cause of Trouble
1	I-F Circuit	Set front panel controls to: GAIN--Fully clockwsie DEVIATION--max. CENTER FREQ. --100 SCALE--RMS SCALE MULTIPLIER--X1 VIDEO FILTER--OFF Apply a 225-kc .9mv signal to pin 6 of tube V201. Adjust frequency of applied for maximum vertical rise of trace.	A baseline deflection to the top of graticule.	NOTE: If indication is normal, i-f circuit operating properly, proceed to step 2.
2		Apply a 225-kc .6 mv signal to pin 6 of tube V202	A baseline deflection to the top of graticule.	If indication is normal replace tube V201 and/or defective associated circuitry. If indication abnormal, proceed to step 3.
3		Apply a 225-kc .3 mv signal to pin 1 of tube V203.	A baseline deflection to the top of graticule.	If indication is normal replace tube V202 and/or associated defective circuitry. If indication abnormal, proceed to step 4.
4		Apply a 225-kc 4 mv signal to pin 1 of tube V204	A baseline deflection to the top of graticule	If indication is normal replace tube V203, and/or defective associated circuitry. If indication abnormal, proceed to step 5.
5		Apply a 225-kc 70 mv signal to pin 1 of tube V205	A baseline deflection to the top of graticule.	If indication is normal replace tube V204 and/or defective associated circuitry. If indication

Table 4-4. IF Circuit Trouble Shooting Table (Sheet 1 of 2)

Step	Trouble	Procedure	Normal Indication	Probable Cause of Trouble
5 (cont'd)				abnormal, proceed to step 6.
6		Apply a 225-kc, 45 volt signal to pin 7 of tube V206.	A baseline deflection to the top of graticule.	If indication is abnormal, replace tube V206 and/or defective associated circuitry. If indication is normal replace tube V205 and/or defective associated circuitry.

Table 4-4. IF Circuit Trouble Shooting Table (Sheet 2 Of 2)

4-12. SYSTEM TROUBLE SHOOTING PROCEDURES

4-13. The following procedure should be used to isolate an equipment malfunction to a particular stage as shown in figure 4-1. This procedure checks out all the circuitry of the Model TA-121L and is to be followed when an equipment malfunction cannot be located by using the detailed trouble shooting procedures given in table 4-3 and 4-4.

NOTE

All internal adjustment controls have been factory set for optimum equipment operation. Therefore, in isolating a trouble, adjustment of these controls should not be made.

4-14. Set the front panel controls to:

VIDEO FILTER	-	OFF
DEVIATION KC/S	-	Maximum
CENTER FREQ.	-	100
GAIN	-	Fully clockwise
ATTENUATOR	-	X1
SCALE MULTIPLIER	-	X1
SCALE	-	RMS
MARKERS	-	OFF
SEARCH/ANALYZER	-	ANALYZER

4-15. Turn POWER switch to ON and allow 30 minutes for equipment to warm up.

NOTE

The following steps are numbered in the same relationship as shown in figure 4-1.

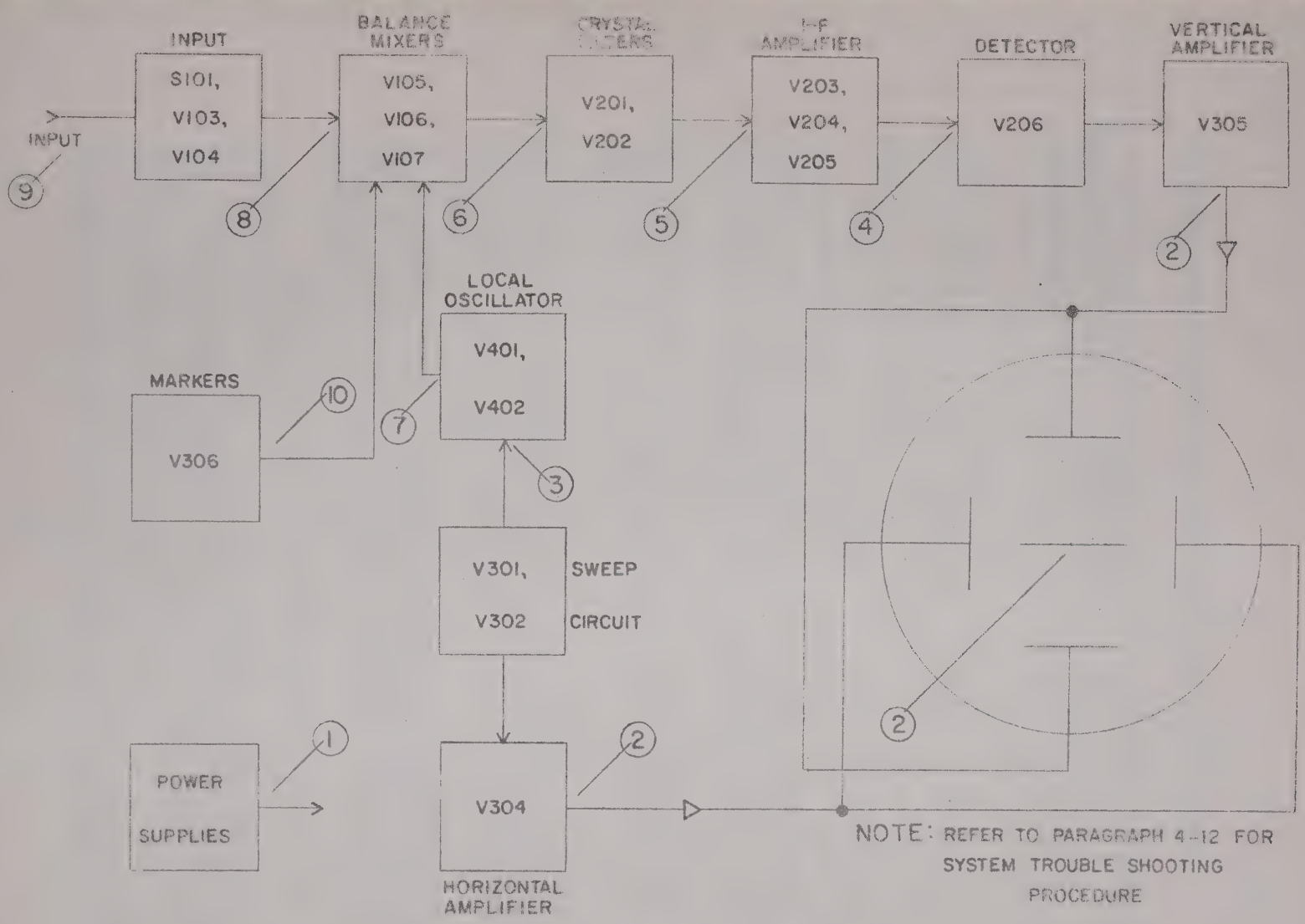


FIGURE 4-1 SYSTEM TROUBLE SHOOTING BLOCK DIAGRAM

(1) Check power supplies as indicated in the table below:

Multimeter Connected Between Ground and	Power Supply Being Checked	Indication Min. vdc	Indication Max. vdc	Adjust.
J504	+270 vdc	+270	+270	R510
V508, pin 2	-105 vdc	-100	-115	None
Junction of C502 & R502	-1300 vdc	+1250	+1350	None
Junction of C503 & R503	-800 vdc	-680	-830	None
J503	Filament	+101	+101	R516

If any of the above power supply voltages cannot be obtained (even after adjustment), trouble shoot the associated circuit of the defective power supply for defective tube(s) and/or components. If all indications are normal, proceed to step 2.

(2) Check the sweep circuit by observing if a trace or dot is visible on the crt screen. If the trace is observed, proceed to step (4). If the dot is observed, proceed to step (3). If the trace or dot is not visible, follow the procedure given below.

a. With a multimeter, record the voltage between pin 1 of V305 and ground; and between pin 6 of V305 and ground. Adjust Vert. Pos. control R337 and note if the two voltages can be brought within 10% of each other. If improper, replace tube V305 and/or defective associated circuitry.

b. With a multimeter, record the voltage between pin 1 of V304 and ground; and between pin 6 of V304 and ground. Adjust Hor. Pos. control R327 and note if the two voltages can be brought within 10% of each other. If improper, replace tube V304 and/or defective associated circuitry.

c. Check cathode ray tube and associated circuitry for defective component(s).

(3) Connect an oscilloscope to the junction of R401 and C401 in the local oscillator assembly. A 6.0 volt peak-to-peak sawtooth waveform should be observed (with a period of one second). If proper, proceed to step (4). If improper, replace tube V301 or V302 and/or defective associated component.

(4) Apply a 225-kc 45 volt signal (calibrated) to pin 7 of V206. A horizontal base line rise of 10 boxes should be observed on the

crt screen. If improper, replace tube V206 and/or defective associated circuitry. If proper, proceed to step 5.

(5) Apply a 225-kc .3 mv signal to pin 1 of tube V203. A full scale base line deflection should be observed on the crt screen. If improper, replace tube V203, V204, or V205, and/or defective associated circuitry. If proper, proceed to step 6. (Refer to table 4-4, for more detailed trouble shooting procedure of the i-f amplifier).

(6) Apply a 225-kc, .9 mv signal to pin 6 of V201. Adjust the frequency of the applied signal for maximum horizontal width display of the signal on the crt screen. A full-scale base line deflection should be observed on the crt screen. If improper, replace tube V201 or V202 and/or defective associated circuitry. (Refer to paragraph 4-29 for alignment of the crystal driven filter amplifiers if crystal Y201 or Y202, or an associated component was replaced.) If proper, proceed to step 7.

(7) Connect the oscilloscope to pin 1 of V402. A 2.0V sweeping sine wave signal should be observed on the oscilloscope. If improper, replace tube V401 or V402 and/or associated defective circuitry. (Refer to paragraph 4-31 for alignment of the local oscillator if a component was replaced.) If proper, proceed to step 8.

(8) Apply a 100-kc, .4 mv signal to pin 1 of V105. Apply the same signal to pin 1 of V106. Note a full-scale base line deflection in each case. If improper, replace tube V105 or V106 and/or associated defective circuitry. If proper, proceed to step 9.

(9) Apply a 100-kc, 500 microvolt (calibrated) to the INPUT/GND receptacles. Note a full-scale pip deflection. If improper, replace tube V103 or V104 and/or associated defective circuitry.

(10) Set the MARKERS switch to ON. Note that a 100 kc marker pip is displayed on the crt screen. If improper, replace tube V306 or crystal Y301 and/or associated defective circuitry.

Reference Symbol	Tube Type	Adjustment to be Made
V103	12AY7	None
V104	5079	Harmonic Balance control R119, refer to paragraph 4-25.
V105, V106	6BH6	Balance Phasing control C107, refer to paragraph 4-24.
V107	6AB4	Gain Calibrate control R201, refer to paragraph 4-26.
V201,V202	6AB4	None
V203,V204 V205	12AU6	None (In some cases a slight peaking if the associated i-f transformer coil may be required.
V206	604	DB Shape control R241 and DB Range control R243, refer to paragraph 4-23.
V301	12AU7	Rate control R301, refer to paragraph 4-21. Sweep circuit alignment, refer to paragraph 4-30. Line Size control R322 and Horizontal Position control R327, refer to paragraph 2-10.
V302	6072	Sweep circuit alignment, refer to paragraph 4-30.
V303	85A2/5651	ZERO FREQ. CALIB. control, refer to paragraph 2-9.
V304	12AX7	Line Size control R322 and Horizontal Position control R327, refer to paragraph 2-10.
V305	12AX7	Vertical Position control R337, refer to paragraph 2-10.
V306	6AB4	None.
V401	6201	Local Oscillator alignment, refer to paragraph 4-31.
V402	12AT7	None
V505	6AS7G	B+ Adjust control R510, refer to paragraph 4-20.

Table 4-5. Tube Replacement Adjustment Procedure (Sheet 1 of 2)

Reference Symbol	Tube Type	Adjustment to be Made
V506	12AU6	B+ Adjust control R510, refer to paragraph 4-20.
V507	85A2/5651	B+ Adjust control R510, refer to paragraph 4-20.
V508	OB2	None
V521	5ADP7	Presentation controls, refer to paragraph 2-10.

Table 4-5. Tube Replacement Adjustment Procedure(Sheet 2 of 2)

4-16. ADJUSTMENT AND ALIGNMENT INSTRUCTIONS

4-17. The following paragraph detail the procedure for adjusting various internal controls which may be required due to replacement of components or aging of tubes. Instructions are also provided for alignment of the i-f circuit, and local oscillator. Refer to tables 4-2 through 4-5 to determine the applicable adjustment or alignment procedure required to bring the Model TA-120L to satisfactory operating condition. Allow at least 30 minutes of warm-up time for the equipment to stabilize before performing any adjustment or alignment procedure.

4-18. ADJUSTMENTS

4-19. FILAMENT ADJUST R516. Connect a multimeter between test point J503 and chassis. Adjust potentiometer R516 until meter indicates exactly 101.1 volts dc.

4-20. B+ ADJUST R510. Connect a multimeter between test point J504 and chassis. Adjust potentiometer R510 until meter indicates exactly +270 volts dc.

4-21. RATE CONTROL R301. The sweep trace on the cathode ray tube is to be adjusted for one sweep every two seconds. Follow the procedure below to adjust this control.

(1) Connect the vertical input of an oscilloscope to the Sync Out jack J302.

(2) Adjust R301 until the signal display (sawtooth) on the oscilloscope has a period of one second.

(3) When adjusting R301, readjustment of line size control (R322) and horizontal positioning control (R327) may be required. (Refer to paragraph 2-10.)

4-22. GAIN COMPENSATE CONTROL R225. This control is to be adjusted for maintaining amplitude flatness of a signal pip as the deviation kc/s is varied from minimum to maximum.

4-23. DB SHAPE CONTROL R241 AND DB RANGE CONTROL R243. These are used to set the log shaping circuit for proper logarithmic display on the crt. Follow the procedure below to perform this adjustment.

(1) Set the front panel controls to:

SCALE MULTIPLIER -- X1
ATTENUATOR -- X1K
GAIN -- Fully clockwise
SCALE -- RMS
DEVIATION KC/S -- Minimum
CENTER FREQUENCY -- 50
SEARCH/ANALYZER -- Analyzer

(2) Apply a 50 kc signal to the equipment. Adjust the 50 kc signal level for a full-scale deflection on the crt.

(3) Set SCALE switch to DB. Set ATTENUATOR switch to X100.

(4) If the signal pip is not directly at the +20 DB screen indication, adjust DB range control R243 until signal pip is directly at 20 DB screen indication.

(5) Set ATTENUATOR control to X1K.

(6) Adjust DB Shape control R241 until the signal pip is at the 0 DB screen indication.

(7) DB Range control R243 and Shape control R241 may require several back-and-forth adjustments before the signal accurately follows the scale calibrations.

4-24. BALANCE PHASING CONTROL C107. If, after sufficient warm-up time, the zero-frequency pip cannot be reduced to at least one-quarter full screen deflection with front panel control set to: SCALE MULTIPLIER - X1; and DEVIATION KC/S - .05, adjust control C107 as follows:

(1) Adjust BALANCE controls for maximum suppression of zero-frequency pip. (Refer to paragraph 2-12.)

(2) Adjust control C107 for further reduction of zero-frequency pip to at least one-quarter full scale with controls set as above.

4-25. HARMONIC BALANCE CONTROL R119. This control is used to insure at least 60 db of harmonic rejection. To adjust this control proceed as follows:

(1) Set front panel controls to:

CENTER FREQUENCY -- 2
DEVIATION KC/S -- maximum
SEARCH ANALYZER -- analyzer
VIDEO FILTER -- off
SCALE -- RMS
ATTENUATOR -- X10
SCALE MULTIPLIER -- X100

(2) Apply a 2-kc signal to the INPUT/GND terminals of the equipment.

(3) Adjust 2-kc signal for full-scale deflection on CRT.

(4) Set SCALE switch to DB, SCALE MULTIPLIER control to X1.

(5) If the 4-kc harmonic signal pip is below the -20 DB marking on the right side of the CRT screen, adjustment of R119 need not be required. If the harmonic signal pip is above the -20 DB marking, adjust R119 for minimum signal amplitude of harmonic signal. Relock R119.

4-26. GAIN CALIBRATE CONTROL R201. This control is used to calibrate the cathode ray tube screen for voltage measurements. To adjust this control proceed as follows:

(1) Set front panel controls to:

DEVIATION KC/S -- 5
CENTER FREQUENCY -- 10
ATTENUATOR -- X1
GAIN -- fully clockwise
SCALE MULTIPLIER -- X1
SCALE -- RMS
VIDEO FILTER -- off
SEARCH/ANALYZER -- analyzer

(2) Apply a 10 kc, 500 microvolt signal (calibrated to the equipment.

(3) Adjust control R201 to give a full scale signal deflection on cathode ray tube screen.

4-27. ALIGNMENT PROCEDURES.

4-28. I-F Circuit. The following procedure is given for aligning the i-f circuit:

(1) Set the front panel controls to:

CENTER FREQUENCY -- 10
GAIN -- fully clockwise
DEVIATION KC/S -- Maximum
SEARCH/ANALYZER -- Analyzer
SCALE -- RMS
ATTENUATOR -- X1
SCALE MULTIPLIER -- X1
VIDEO FILTER -- off

(2) Remove the unit from the cabinet. Remove the bottom plate and i-f bottom plate.

(3) Adjust the Gain Calibration Control R201 to its mid-range.

(4) Apply a 225-kc signal (calibrated) through a 0.01 capacitor to pin 1 of tube V205. Adjust the 225-kc signal level until the baseline on the CRT is about halfway up on the screen.

NOTE

Use the 0.01 capacitor on all remaining steps.

(5) Adjust i-f transformer Z203 for maximum vertical deflection of baseline. The level of the applied 225-kc signal should be approximately 70 millivolts. Remove the signal.

(6) Apply the 225-kc signal to pin 1 of tube V204. Adjust i-f transformer Z202 for maximum vertical deflection of the baseline. The level of the applied 225-kc signal should be approximately 4 millivolts. Remove the signal.

(7) Apply the 225-kc signal to pin 1 of tube V203. Adjust i-f transformer Z201 for maximum vertical deflection of the baseline. The level of the applied 225-kc signal should be approximately 300 uvolts. Remove the signal.

(8) Apply the 225-kc signal to pin 6 of tube V202. Adjust slightly the frequency of the 225-kc signal for maximum vertical rise of baseline. Adjust the level of the 225-kc signal for maximum vertical deflection of the baseline. The level of this signal should be approximately 600 uvnolts. Remove the signal.

(9) Apply the 225-kc signal to pin 6 of tube V201. Adjust slightly the frequency of the 225-kc signal for maximum vertical rise of baseline. Adjust the level of the 225-kc signal for maximum deflection of the baseline. The level of the applied 225-kc signal should be approximately 0.9 millivolts. Z201, Z202, Z203 should now be adjusted for maximum output.

(10) Apply the 225-kc signal to pin 6 of tube V107. Adjust Gain Calibration control R201 for maximum vertical deflection of the baseline. The level of the applied 225-kc signal should be approximately 0.9 millivolts. Remove the signal.

(11) Apply the 225-kc signal to pin 1 of tube V105. Adjust transformer Z102 for maximum vertical deflection of the baseline. Apply the 225-kc signal to pin 1 of tube V106. Adjust transformer Z102 for maximum vertical deflection of the baseline. Apply the 225-kc signal a few times to pin 1 of tubes V105 and V106 and adjust transformer Z102 for maximum vertical deflection of the baseline. The level of the applied 225-kc signal should be approximately 400 uvolts. Remove the signal.

(12) Connect an oscilloscope to pin 7 of tube V106. Note the frequency displayed is sweeping around 235-kc at an amplitude of 2 volts. Disconnect the oscilloscope.

(13) Apply a 10-kc, 400 uvolt signal to pin 1 of tube V104. Note a full-scale signal pip is directly at the center of the screen.

(14) Apply a 10-kc, 500 microvolt signal to the INPUT/GND terminals. Note a full-scale signal pip is directly at the center of the screen. If required, adjust Gain Calibrate Control R201 for full-scale signal pip.

4-29. CRYSTAL DRIVEN FILTER AMPLIFIERS V201 AND V202. Alignment of this circuit should only be performed after replacement of crystals Y201 and Y202. To align this circuit proceed as follows:

(1) Set front panel controls to:

CENTER FREQUENCY -- 10
VIDEO FILTER -- off
DEVIATION KC/S -- Maximum
SCALE -- RMS
ATTENUATOR -- X10
SCALE MULTIPLIER -- X10
SEARCH/ANALYZER -- Analyzer

(2) Remove the unit from the cabinet. Remove the bottom plate and i-f bottom plate.

(3) Apply a 10-kc signal to the INPUT/GND terminals. Adjust the signal level for full-scale deflection of the signal pip. Adjust the CENTER FREQUENCY control until the signal is directly at the center of the screen.

(4) Remove crystal Y201. Short-out crystal socket Y201 by connecting a clip lead between socket pins of removed crystal Y201.

(5) Unlock and adjustment MANUAL RESOLUTION control to mid-range.

(6) Adjust crystal trimmer C208 for minimum signal amplitude on screen.

(7) Set DEVIATION KC/S control to minimum.

(8) Adjust input level of 10-kc signal for full-scale deflection of signal pip on screen. Set ATTENUATOR to X1. and SCALE to DB.

(9) Adjust neutralizing capacitor C206 to obtain signal pip as shown in figure 4-2.

(10) Remove clip lead and re-insert crystal Y201. Remove crystal Y202 and insert clip between socket pins of removed crystal Y202.

(11) Set DEVIATION KC/S control to maximum, ATTENUATOR to X10 and SCALE to RMS.

(12) Adjust applied signal level of 10-kc signal for full-scale deflection.

(13) Adjust crystal trimmer C204 for minimum signal amplitude on screen.

(14) Set DEVIATION KC/S control to minimum.

(15) Adjust input level of 10-kc signal for full-scale deflection. Set ATTENUATOR to X1 and SCALE to DB.

(16) Adjust neutralizing capacitor C202 to obtain signal pip as shown in figure 4-2.

(17) Remove clip lead and re-insert crystal Y202.

(18) Set DEVIATION KC/S control to 5, ATTENUATOR to X10 and SCALE to RMS.

(19) Adjust input signal level for full-scale deflection.

(20) Set DEVIATION KC/S control to 10.

(21) Adjust Gain Compensate control R225 for full-scale signal deflection.

(22) Repeat steps (20) and (21) until no interaction between controls is observed.

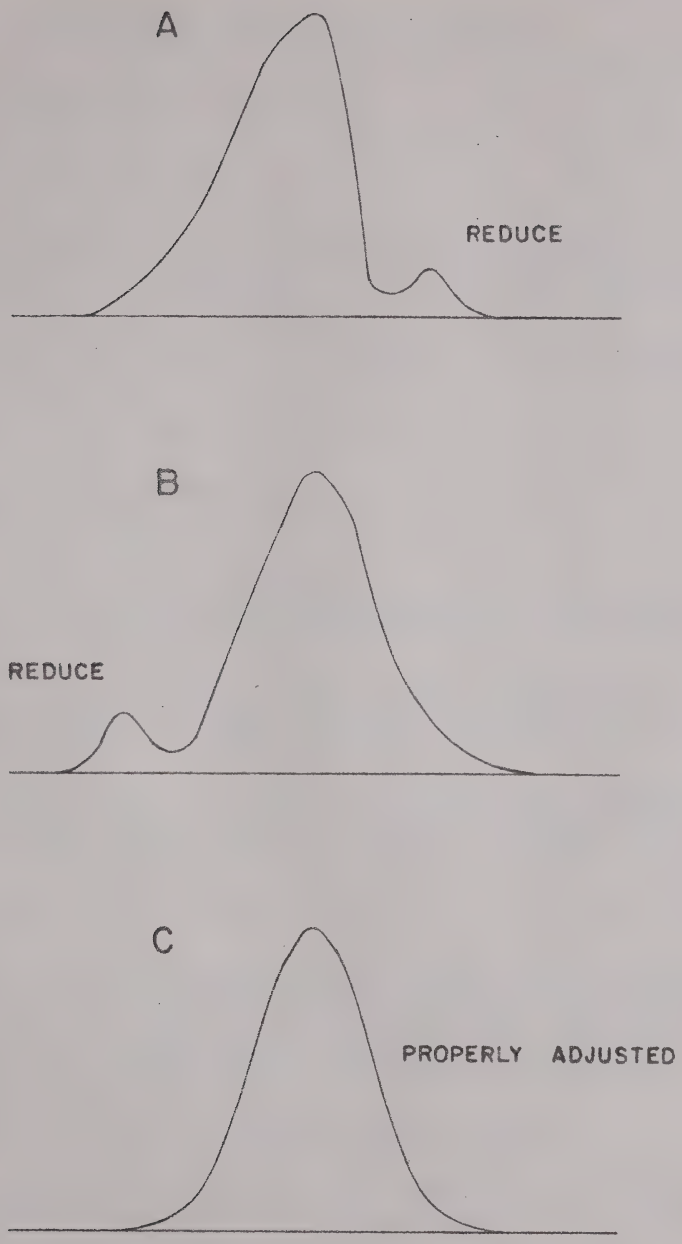


FIGURE 4-2 CRYSTAL DRIVEN FILTER
AMPLIFIER RESPONCE

(23) Set DEVIATION KC/S control tominimum.

(24) Adjust MANUAL RESOLUTION control for full-scale deflection of signal pip on screen.

(25) Repeat stesp (23) and (24) until no interaction between controls is observed.

(26) Rotate DEVIATION KC/S control from minimum to maximum and note that signal pip amplitude does not vary more than 2 divisions. If improper, repeat steps 18 through 26 until proper response is obtained.

4-30. SWEEP CIRCUIT. To align the sweep circuit V301 and V302 proceed as follows:

(1) Set front panel controls to:

CENTER FREQUENCY -- 0
DEVIATION KC/S -- 0.05
SCALE -- RMS

(2) Adjust the CENTER FREQUENCY control slightly so that the zero frequency pip appears under the 0 deviation point on the CRT graticule.

(3) Set the DEVIATION control to 10. Adjust the S.W. BAL. control (R308) to return the zero frequency pip to the 0 deviation point on the CRT graticule.

(4) Repeat steps (2) and (3) until the zero frequency pip remains under the 0 deviation point on the CRT graticule as the DEVIATION control is varied from 0.05 to 10.

(5) Apply a 10 kc signal (calibrated) the the INPUT/GND terminals.

(6) Adjust sweep width maximum control, R305, until the 10 kc signal pips are directly in line with the 100% deviation lines on both sides of the CRT graticule, and the zero-frequency pip is directly in line with the 0 deviation marking on the CRT graticule.

(7) Set the DEVIATION KC/S control to 0.05.

(8) Apply a 100 cps signal (calibrated) to the INPUT/GND terminals.

(9) Adjust minimum sweep width control, R313, until the 100 cps signal pips are directly in line with the 100% deviation lines on both sides of the CRT graticule.

4-31. LOCAL OSCILLATOR V401. To align the local oscillator proceed as follows:

(1) Set front panel controls to:

CENTER FREQ. -- 0
DEVIATION KC/S -- 10
SCALE -- RMS
VIDEO FILTER -- OFF
ATTENUATOR -- X1
SCALE MULTIPLIER -- X10
ZERO FREQ. CALIB -- Mid-range

(2) Note the zero-frequency pip is directly over the center graticule of the screen. (Rotate the DEVIATION KC/S control towards 0.05 and adjust the GM Comp. control R405, to maintain signal in middle of screen if the zero frequency pip shifts position.

(3) Set DEVIATION KC/S control to maximum.

(4) Set CENTER FREQUENCY control to 20.

(5) Apply a 20 kc signal (calibrated to the INPUT/GND terminals.

(6) Note the 20 kc signal pip is approximately at the center of the screen.

(7) Rotate the DEVIATION KC/S control towards 0.05. To maintain the 20 kc signal pip at the center of the screen, adjust transformer Z401.

(8) The entire procedure may have to be repeated several times in order to optimize the local oscillator circuit adjustment.

4-32. REMOVAL AND REPLACEMENT INSTRUCTIONS.

4-33. To remove the main chassis from the cabinet, remove the eight screws from the side of the front panel and pull the chassis from the cabinet. Side brackets on the main chassis enable the equipment to be placed in any convenient position for ease of maintenance. The right side bracket has two spare fuses and an alignment tool (tuning wand). To obtain access to the i-f circuits remove the two bottom plates.

4-34. Maintenance of the local oscillator assembly is made more convenient by removal from the main chassis. To remove the local oscillator assembly, remove the three screws from the side bracket and pull the assembly out of its plug-in socket. The parts in the local oscillator circuit are temperature-compensated; therefore, it is recommended that replacement of the entire assembly be made rather than individual components (except tubes).

4-35. CATHODE RAY TUBE. To remove the cathode ray tube, proceed as follows:

(1) Remove the four screws from bezel, screen, and amber filters.

(2) Remove cathode ray tube socket and unscrew neck clamp screw.

(3) Push cathode ray tube as far back into the mu-metal shield as possible.

(4) When the cathode ray tube is clear of the rubber ring, remove the rubber ring and cathode ray tube.

(5) To reinstall a cathode ray tube, proceed as follows.

(6) Insert the cathode ray tube in the shield pushing as far back as possible.

(7) Be sure anode connection is facing up.

(8) Replace rubber ring and then dust rubber ring with a fine talc powder to prevent the tube from sticking in the rubber ring.

(9) Push cathode ray tube forward by placing the palm of the hand on socket on end of tube and pushing forward with even pressure.

(10) Replace tube oscket and attach anode connector.

(11) Turn-on the equipment. If the trace does not line up parallel with the horizontal lines of the screen, push the tube back until it clears the rubber ring and turn tube until trace aligns with screen markings.

(12) Push tube back into rubber ring.

(13) Replace screen, filter, and bezel.

4-36. EDGE LIGHTING LAMPS. To remove a defective lamp, proceed as follows:

(1) Remove bezel, filter, and screen.

(2) Four edge lighting lamps are now visible.

(3) Push in, turn counterclockwise, and remove defective lamp.

(4) Push in new lamp into place and turn it clockwise until it locks.

(5) Replace screen, filter, and bezel.

SECTION V

PARTS LIST

1. This parts list provides a listing of all replaceable parts required for normal maintenance of the equipment.

   The list contains the following information:

   a. Reference Symbol. This number identifies the part and also appears on the schematic and on any illustrations referencing this part.

   b. Description. This is a description of the part which includes voltage ratings, current ratings etc., where necessary.

   c. Manufacturer's Part Number. This column contains the part number assigned by the manufacturer.

   d. Manufacturer's Code. This column contains a letter code identifying the manufacturer of the part. The listing of the letter codes follows immediately after this Spare Parts List.

   e. Maintenance Quantity. This column contains the recommended maintenance quantity for each part, based on the number used, and a one-year requirement for the equipment operating eight hours a day throughout the year.

2. Ordering Information -

   When ordering parts from the factory, always include the following:

   a. Instrument model number and name.

   b. Serial number.

   c. Reference symbol.

   d. Manufacturer's part number, description, and code.

PARTS LIST

REF. SYMBOL	DESCRIPTION	MANUFACTURER PART NUMBER	MFR'S CODE	MAINT QTY.
R101	RES.,FIXED,CARBON DEPOSIT, 150K 1% 2W	C2C	AA	1
R102	Same as R101			
R103	Same as R101			
R104	RES.,FIXED,CARBON DEPOSIT, 5K 1% 1W	C1C	AA	1
R105	RES.,FIXED,CARBON DEPOSIT, 500 1% ½W	C½C	AA	1
R106	RES.,FIXED,CARBON DEPOSIT, 50 1% ½W	C½C	AA	1
R107	RES.,FIXED,CARBON DEPOSIT, 11 1% ½W	C½C	AA	1
R108	Same as R107			
R109	RES.,FIXED,COMP, 220K 10% 2W	RC42GF224K	AA	1
R110	RES.,FIXED,COMP, 1.2K 10% ½W	RC20GF122K	AB	1
R111	RES.,FIXED,COMP, 3.3 Meg 10% ½W	RC20GF335K	AB	1
R114	RES.,VAR.,COMP, 50K 10% 2W	Type JU	AB	1
R115	RES.,FIXED,COMP, 5.1K 5% ½W	RC20GF512J	AB	1
R116	RES.,FIXED,COMP, 47K 10% 1W	RC32GF473K	AB	1
R117	RES.,FIXED,COMP, 22K 10% ½W	RC20GF223K	AB	1
R118	RES.,FIXED,COMP 18K 10% ½W	RC20GF183K	AB	1
R119	RES.,VAR.,COMP, 10K 10% 2W	Type JU	AB	1
R120	RES.,FIXED,COMP, 100K 10% ½W	RC20GF104K	AB	4
R121	RES.,FIXED,COMP, 39K 10% ½W	RC20GF393K	AB	1
R123	RES.,FIXED,COMP, 1 Meg 10% ½W	RC20GF105K	AB	1
R124	Same as R120			
R125	RES.,FIXED,COMP, 2.2 Meg 10% ½W	RC20GF225K	AB	1
R126	Same as R125			
R127	Same as R120			
R128	Same as R120			
R129	RES.,FIXED,COMP, 510 ohm 5% ½W	RC20GF511J	AB	1

PARTS LIST

REF. SYMBOL	DESCRIPTION	MANUFACTURER PART NUMBER	MFR'S CODE	MAINT QTY.
R130	Same as R121			
R131	Same as R121			
R132	RES.,VAR.,WW, 10-Turn 50K	62JA-50K	AC	1
R136	RES.,FIXED,COMP, 68K 10% ½W	RC20GF683K	AB	1
R137	RES.,FIXED,COMP, 33K 10% ½W	RC20GF333K	AB	1
R138	RES.,VAR.,COMP, 25K 10% 2W	Type JU	AB	1
R139	RES.,FIXED,COMP, 56K 10% 1W	RC32GF563K	AB	1
R140	RES.,FIXED,COMP, 10K 10% ½W	RC20GF103K	AB	1
R141	RES.,FIXED,COMP, 8.2K 10% ½W	RC20GF822K	AB	1
R201	Same as R141			
R202	RES.,FIXED, CARBON DEPOSIT, 50K 1% ½W	C½C	AA	1
R203	RES.,FIXED,CARBON DEPOSIT, 5K 1% ½W	C½C	AA	1
R204	Same as R105			
R205	RES.,FIXED,CARBON DEPOSIT, 54.9 1% ½W	C½C	AA	1
R207	RES.,FIXED,COMP, 10K 10% 2W	RC42GF103K	AB	1
R208	RES.,FIXED,COMP, 200 5% ½W	RC20GF201J	AB	1
R209	Same as R208			
R210	RES.,VAR.,COMP, 100K 10% 2W	Type JA	AB	1
R211	RES.,VAR.,COMP,DUAL, 5K 2W	CCU5021	AD	1
R212	Factory Adjust			
R213	Same as R207			
R214	Same as R208			
R215	Same as R208			

PARTS LIST

REF. SYMBOL	DESCRIPTION	MANUFACTURER PART NUMBER	MFR'S CODE	MAINT. QTY.
R216	Same as R210			
R217	Part of R211			
R219	RES.,FIXED,COMP, 4.7K 10% ½W	RC20GF472K	AB	1
R220	RES.,FIXED,COMP, 47K 10% ½W	RC20GF473K	AB	1
R221	Factory Adjust			
R222	RES.,FIXED,COMP, 2.2K 10% ½W	RC20GF222K	AB	1
R223	Factory Adjust			
R224	Factory Adjust			
R225	Same as R138			
R226	Same as R210			
R227	Factory Adjust			
R228	RES.,FIXED,COMP, 82K 10% 1W	RC32GF823K	AB	1
R229	Same as R139			
R230	Same as R222			
R231	Factory Adjust			
R232	Same as R120			
R233	RES.,FIXED,COMP, 100 ohm 10% ½W	RC20GF101K	AB	2
R234	Same as R233			
R235	Same as R116			
R236	RES.,FIXED,COMP, 5.6K 10% 1W	RC32GF562K	AB	1
R237	Same as R120			
R238	RES.,FIXED,COMP, 150 ohm 10% ½W	RC20GF151K	AB	1
R239	RES.,FIXED,COMP, 15K 10% 1W	RC32GF153K	AB	1
R240	RES.,FIXED,COMP, 33K 10% 1W	RC32GF33K	AB	1
R241	Same as R144			
R242	Same as R136			

PARTS LIST

REF. SYMBOL	DESCRIPTION	MANUFACTURER PART NUMBER	MFR'S CODE	MAINT. QTY
R243	RES.,VAR.,COMP, 250K 10% 2W	Type JU	AB	1
R244	RES.,FIXED,COMP, 150K 10% ½W	RC20GF154K	AB	1
R245	RES.,FIXED,COMP, 56K 10% ½W	RC20GF563K	AB	1
R246	RES.,FIXED,COMP, 220K 10% ½W	RC20GF224K	AB	2
R301	RES.,VAR.,COMP, 2 Meg 10% 2W	Type JU	AB	1
R302	Same as R125			
R303	RES.,FIXED,COMP, 8.2 Meg 10% ½W	RC20GF825K	AB	1
R304	RES.,FIXED,COMP, 470K 10% ½W	RC20GF474K	AB	1
R305	Same as R301			
R306	Same as R220			
R307	Same as R219			
R308	RES.,VAR.,COMP, 100K 10% 2W	Type JU	AB	1
R309	RES.,VAR.,COMP, 5 Meg 20% 2W	Type JU	AB	1
R310	Factory Adjust			
R311	Factory Adjust			
R312	RES.,VAR.,COMP, 2.5 Meg 10% 2W	Type JA	AB	1
R313	Same as R114			
R314	Same as R121			
R315	RES.,FIXED,COMP, 68K 10% 2W	RC42GF683K	AB	1
R316	RES.,VAR.,COMP, 10% 2W 5K	Type JU	AB	1
R317	Factory Adjust			
R318	RES.,VAR.,WW, 10-Turn 50K	Model 860	AE	1
R319	RES.,FIXED,CARBON DEPOSIT, 10K 1% ½W	C½C	AA	1

PARTS LIST

REF. SYMBOL	DESCRIPTION	MANUFACTURER PART NUMBER	MFR'S CODE	MAINT. QTY.
R320	Same as R319			
R321	Same as R239			
R322	RES.,VAR.,COMP, 500K 2W 10%	Type JU	AB	1
R323	Same as R120			
R324	Same as R120			
R325	Same as R120			
R326	RES.,FIXED,COMP, 220K 10% 1W	RC32GF224K	AB	1
R327	Same as R316			
R328	RES.,FIXED,COMP, 3.3K 10% ½W	RC20GF332K	AB	1
R329	RES.,FIXED,COMP, 27K 10% ½W	RC20GF273K	AB	1
R330	Same as R329			
R331	Same as R120			
R332	Same as R120			
R333	Same as R120			
R334	Same as R120			
R335	Same as R120			
R336	Same as R120			
R337	Same as R119			
R338	Same as R326			
R339	Same as R120			
R340	Same as R220			
R341	Same as R125			
R342	RES.,FIXED,COMP, 560K 10% ½W	RC20GF564K	AB	1
R344	RES.,FIXED,COMP, 22 Meg 10% ½W	RC20GF226K	AB	1

PARTS LIST

REF. SYMBOL	DESCRIPTION	MANUFACTURER PART NUMBER	MFR'S CODE	MAINT. QTY.
R401	RES.,FIXED,CARBON DEPOSIT,150K 1% 1W	C1C	AA	1
R402	Same as R233			
R403	Not Used			
R404	RES.,FIXED,CARBON DEPOSIT,24.9K 1% ½W	C½C	AA	1
R405	Same as R138			
R406	RES.,FIXED,CARBON DEPOSIT,8.2K 1% 2W	C2C	AA	1
R407	RES.,FIXED,WW,20K 20% 10W	1765	AD	1
R408	RES.,FIXED,CARBON DEPOSIT,12K 1% 2W	C2C	AA	1
R409	RES.,FIXED,COMP, 100 10% 2W	RC42GF101K	AB	1
R410	RES.,FIXED,CARBON DEPOSIT,39K 1% 1W	C1C	AA	1
R411	RES.,FIXED,CARBON DEPOSIT,25K 1% 1W	C1C	AA	1
R412	RES.,FIXED,COMP,510K 5% ½W	RC20GF514J	AB	1
R413	RES.,FIXED,COMP,22K 10% 2W	RC42GF223K	AB	1
R414	RES.,FIXED,WW,25K 20% 10W	1767	AD	1
R415	Same as R120			
R416	RES.,FIXED,CARBON,1.5K 10% 2W	RC42GF152K	AB	1
R417	Same as R304			
R450	RES.,FIXED,COMP.,100K ±10% ½W	RC20GF104K	AB	1
R451	RES.,FIXED,COMP.,47K ±10% ½W	RC20GF473K	AB	1
R452	RES.,FIXED,COMP.,4.7K ±10% ½W	RC20GF472K	AB	1
R453	Same as R451			
R454	RES.,FIXED,COMP.,10K ±10% ½W	RC20GF103K	AB	1
R455	RES.,FIXED,COMP.,2.2K ±10% ½W	RC20GF222K	AB	1
R456	RES.,FIXED,COMP.,3.3K ±10% ½W	RC20GF332K	AB	1
R457	Same as R455			

PARTS LIST

REF. SYMBOL	DESCRIPTION	MANUFACTURER PART NUMBER	MFR'S CODE	MAINT QTY.
R458	RES.,VAR.,COMP.,25K ±10% 2W	Type JU	AB	1
R459	Same as R454			
R460	Same as R452			
R461	Same as R452			
R462	Same as R451			
R463	RES.,FIXED,COMP.,15K ±10% ½W	RC20GF153K	AB	1
R464	RES.,FIXED,COMP.,22K ±10% 2W	RC42GF223K	AB	1
R465	Same as R464			
R501				
R501	RES.,FIXED,COMP,100K 10% 2W	RC42GF104K	AB	1
R502	RES.,FIXED,COMP,4.7 Meg 10% 2W	RC42GF475K	AB	1
R503	RES.,FIXED,COMP, 680K 10% 2W	RC42GF684K	AB	1
R504	RES.,FIXED,COMP,5.6 Meg 5% ½W	RC20GF565J	AB	1
R505	Same as R233			
R506	Same as R233			

REF. SYMBOL	DESCRIPTION	MANUFACTURER PART NUMBER	MFR'S CODE	MAINT. QTY.
R507	RES.,FIXED,COMP, 68 10% ½W	RC20GF680K	AB	1
R508	RES.,FIXED,COMP, 91K 5% ½W	RC20GF913J	AB	1
R509	RES.,FIXED,COMP, 180K 10% 2W	RC42GF184K	AB	1
R510	Same as R114			
R511	RES.,FIXED,COMP, 82K 10% ½W	RC20GF823K	AB	1
R512	Same as R328			
R513	Same as R416			
R514	RES.,FIXED,WW, 12K 20% 5W	Koolohm	AF	1
R515	Same as R514			
R516	RES.,VAR.,WW, 100 ohm 25W	0151	AD	1
R517	RES.,VAR.,COMP, 50K 2W	Type JU	AB	1
R518	RES.,FIXED,CARBON, 15K 10% ½W	RC20GF153K	AB	1
R519	Same as R326			
R520	RES.,VAR.,COMP, 250K 2W 10%	Type JU	AB	1
R521	Same as 503			
R522	Same as R322			
R523	Same as R246			
R524	Same as R246			
R525	Same as R246			
R527	Same as R246			
R528	RES.,VAR.,COMP, 50 ohm 2W with switch	Type JS	AB	1
R529	Same as R246			
R530	Same as R123			
R531	RES.,FIXED,WW, 82 20% 3W	450E8205	AF	1
R532	RES.,FIXED,COMP, 470K 10% 1W	RC32GF474K	AB	1

PARTS LIST

REF. SYMBOL	DESCRIPTION	MANUFACTURER PART NUMBER	MFR'S CODE	MAINT QTY.
R533	Same as R502			
R534	RES.,FIXED,COMP, 47 10% ½W	RC20GF470K	AB	1
R535	Same as R534			
R600	RES.,FIXED,CARBON DEPOSIT, 1.8 Meg 1% ½W	C½C	AA	1
R601	Same as R600			
R603	Factory Adjust			
C101	CAP.,TRIMMER,CERAMIC, 7-45UUF	CV11C450	AG	1
C104	CAP.,FIXED,MYLAR, 2UF, 400V 20%	663UW20504W4	AH	1
C105	A80UF 450V B40UF 450V C20UF 450V	TMT3763	AI	1
C107	CAP.,PISTON,TRIMMER,CERAMIC, 1-8UUF	CS6-6	AJ	1
C108	CAP.,FIXED,PAPER, .1UF 400V	10YE104K	AI	3
C109	Same as C108			
C110	Same as C108			
C111	Same as C108			
C112	Same as C108			
C113	CAP.,FIXED,ELECT., A20UF 450V B20UF 450V	TMD2625	AI	1
C114	CAP.,FIXED,SIL,MICA 510UUF 300V 5%	CM15E511J	AK	1
C115	Same as C114			

PARTS LIST

REF. SYMBOL	DESCRIPTION	MANUFACTURER PART NUMBER	MFR'S CODE	MAINT. QTY.
C116	CAP.,FIXED,SIL,MICA, 240UUF 500V 5%	CM15E241J	AK	2
C117	Same as C108			
C118	Same as C108			
C119	CAP.,FIXED,CERAMIC DISK, .02UF GMV 500V	ID203	AD	2
C201	Same as C108			
C202	CAP.,FIXED,TRIMMER, 1.5-7UUF	CV11A070	AG	1
C203	Same as C119			
C204	CAP.,PISTON,TRIMMER,CERAMIC, 3-25UUF	CS6-50	AJ	1
C205	Same as C108			
C206	Same as C202			
C207	Same as C119			
C208	Same as C204			
C209	Same as C119			
C210	Same as C119			
C211	Same as C108			
C212	Same as C116			
C213	Same as C116			
C214	Same as C119			
C215	Same as C119			
C216	Same as C108			
C217	Same as C116			
C218	Same as C116			

PARTS LIST

REF. SYMBOL	DESCRIPTION	MANUFACTURER PART NUMBER	MFR'S CODE	MAINT. QTY.
C219	CAP.,FIXED,SIL,MICA, 130UUF 500V 5%	CM15E131J	AK	1
C220	Same as C119			
C221	CAP,FIXED,CERAMIC DISK, .01UF GMV 600V	DD6-103	AL	1
C222	Same as C113			
C223	Same as C119			
C224	CAP.,FIXED,SIL,MICA, 430UUF 300V 5%	CM15E431J	AK	1
C225	Same as C224			
C226	Same as C108			
C227	Same as C219			
C228	CAP.,FIXED,CERAMIC DISK, 3900UUF GMV 500V	ID-.0039	AL	1
C229	Factory Adjust			
C301	CAP.,FIXED,MYLAR, .33UF 100V 20%	600UE33401W2	AH	1
C302	CAP.,FIXED,MYLAR, .68UF 400V 10%	614G6849W1	AH	1
C303	Not Used			
C304	CAP.,FIXED,SIL,MICA, 1000UUF 500V 10%	CM20E102K	AK	1
C305	Same as C221			
C306	CAP.,FIXED,MYLAR, .047UF 400V 20%	600UE47304W2	AH	1
C307	CAP.,FIXED,MYLAR, .47UF 100V 20%	600UE47401W2	AH	1
C308	Same as C228			
C309	CAP.,FIXED,SIL,MICA, 470UUF 300V 5%	CM15E471J	AK	1
C310	Same as C309			
C311	CAP.,FIXED,SIL,MICA, 160UUF 500V 5%	CM15E161J	AK	1
C312	Same as C108			

PARTS LIST

REF. SYMBOL	DESCRIPTION	MANUFACTURER PART NUMBER	MFR'S CODE	MAINT. QTY.
C313	CAP.,FIXED,SIL,MICA,18UUF 500V 5%	CM15C180J	AK	1
C401	CAP.,FIXED,SIL,MICA,4700UUF 500V 5%	CM30E472J	AK	1
C402	CAP.,FIXED,TEMP,COMPEN,82UUF,600V 2% NPO	TCZ82	AL	1
C403	Same as C307			
C404	Same as C108			
C405	Same as C113			
C406	Same as C309			
C407	Factory Adjust			
C408	CAP.,FIXED,MICA.,.01UF 300V 10%	CM35B103K	AK	1
C409	CAP.,FIXED,SIL,MICA,2400UUF 500V 5%	CM30E242J	AK	1
C410	Not Used			
C411	Same as C119			
C412	Same as C108			
C413	Same as C108			
C414	Same as C108			
C450	CAP.,FIXED,CER.,.02MF 500V	1D203	AK	1
C451	CAP.,FIXED,CER.,.001MF 500V	1D102	AK	1
C452	CAP.,FIXED,MICA,330MMF 500V	CM15E331J	AJ	1
C453	CAP.,FIXED,MICA,200MMF 500V	CM15E201J	AJ	1
C454	Same as C453			
C455	CAP.,FIXED,MICA,240MMF 500V	CM15E241J	AJ	1
C456	CAP.,FIXED,MICA,510MMF 300V	CM15E511J	AJ	1
C457	Same as C455			
C458	CAP.,FIXED,CER.,.01MF 500V	DD6-103	AK	1

PARTS LIST

REF. SYMBOL	DESCRIPTION	MANUFACTURER PART NUMBER	MFR'S CODE	MAINT. QTY.
C459	CAP.,FIXED,PAPER,.1MF ±20% 400V	10YE104K	AI	1
C501	CAP.,FIXED,OIL,2 x .25UF 2000V	A0CM23	AM	1
C502	Same as C501			
C503	CAP.,FIXED,ELECT.,20UF 450V	FP144	AN	1
C504	CAP.,FIXED,ELECT.,16UF 600V	MC16-600	AN	1
C505	Same as C504			
C506	Same as C104			
C507	CAP.,FIXED,ELECT.,10UF 450V	927-552	AI	1
C508	Same as C503			
C509	CAP.,FIXED,ELECT.,2 x 150UF 250VDC	927-1652	AI	1
C510	Same as C509			
C511	Same as C108			
L201	CHOKE,10MH	3542	AO	2
L202	Same as L201			
L203	Same as L201			
L301	Same as L201			
L401	Same as L201			
L402	Same as L201			
L450	COIL,ADJ.,1.8-3.8 MH	200-48/R	AN	1
L451	COIL,FXD.,2.4MH	2500-46	AN	1
L452	Same as L451			
L501	FILTER CHOKE,12H	B281	AP	1
Z101	INPUT FILTER ASSEMBLY	A435B	AP	1
Z102	MIXER COIL ASSEMBLY	A512	AP	1
Z201	IF TRANSFORMER ASSEMBLY, 225KC	A513	AP	1

PARTS LIST

REF. SYMBOL	DESCRIPTION	MANUFACTURER PART NUMBER	MFR'S CODE	MAINT. QTY.
Z202	IF TRANSFORMER ASSEMBLY,225KC	A514	AP	1
Z203	IF TRANSFORMER ASSEMBLY, 225KC	A515	AP	1
Z401	OSCILLATOR COIL ASSEMBLY	A516	AP	1
T301	BLOCKING OSCILLATOR TRANSFORMER	A8122	AQ	1
T501	LINE REGULATOR	A1104	AP	1
T502	POWER TRANSFORMER	B283	AP	1
T503	FILAMENT TRANSFORMER	B283	AP	1
V101	NEON NE-2 T2 BULB		AR	2
V103	TUBE,ELECTRON, 12AY7		AS	1
V104	TUBE,ELECTRON 5879		AS	1
V105	TUBE,ELECTRON,6BH6		AS	1
V106	Same as V105			
V107	TUBE,ELECTRON,6AB4		AS	2
V201	Same as V107			
V202	Same as V107			
V203	TUBE,ELECTRON, 12AU6		AS	2
V204	Same as V203			
V205	Same as V203			
V206	TUBE,ELECTRON,6C4		AS	1
V301	TUBE,ELECTRON, 12AU7		AS9	1
V302	TUBE,ELECTRON, 6072		AS	1
V304	TUBE,12AX7		AS	2
V305	Same as V304			
V306	Same as V107			
V401	TUBE, 6201		AS	1
V402	TUBE, 12AT7		AS	1
V505	TUBE, 6AS7G		AS	1

PARTS LIST

REF. SYMBOL	DESCRIPTION	MANUFACTURER PART NUMBER	MFR'S CODE	MAINT. QTY.
V506	Same as V203			
V507	TUBE,85A2/5651		AS	1
V508	TUBE,0B2		AS	1
V515	PILOT LIGHT,6.3V, MIN. BAY	#47	AS	6
V516	Same as V515			
V517	Same as V515			
V518	Same as V515			
V519	Same as V515			
V520	Same as V515			
V521	CATHODE RAY TUBE,5ADP7		AT	1
CR450	CRYSTAL,225KC		AQ	1
CR451	ZENER DIODE,15V 10W		AZ	1
CR502	H.V. RECTIFIER,1810 PIV	SS95HP	AV	2
CR503	Same as CR502			
CR504	DIODE,SILICON,SR 3011,600 PIV 350MA		AV	6
CR505	Same as CR504			
CR506	Not Used			
CR507	Same as CR504			
CR508	Same as CR504			
CR509	Not Used			
CR510	Same as CR504			
CR511	Same as CR504			
CR512	Same as CR504			
CR513	Same as CR504			
CR514	Same as CR504			
CR515	Same as CR504			
CR516	Not Used			

PARTS LIST

REF. SYMBOL	DESCRIPTION	MANUFACTURER PART NUMBER	MFR'S CODE	MAINT. QTY.
CR301	MARKER,CRYSTAL,100KC		AW	1
Y201	FILTER,CRYSTAL,225KC		AW	1
Y202	FILTER,CRYSTAL,225KC		AW	1
I509	Same as V101			
I510	Same as V101			
I511	Same as V101			
I512	Same as V101			
I513	Same as V101			
I514	Same as V101			
I602	Same as V101			
F501	FUSE, 2A	AGC	AX	4
F502	Same as F501			
S101	SWITCH,ROTARY,1 POLE,5 POSITION	1400	AL	1
S201	SWITCH,ROTARY,1 POLE,3 POSITION	1472	AL	1
S202	SWITCH,TOGGLE,DPDT	ST22 N	AY	1
S301	SWITCH,ROTARY,1 POLE,4 POSITION	184289-29	AP	1
S302	Same as S202			
S303	SWITCH,ROTARY,2 POLE,2 POSITION	PA302	AL	1
S501	POWER SWITCH, Part of R528,1 POLE 1 POS.			
Q450	TRANSISTOR	2N404	AZ	1
Q451	Same as Q450			
Q452	Same as Q450			
Q453	Same as Q450			

MANUFACTURERS' LIST

AA	Kidco
AB	Allen-Bradley
AC	Clarostat
AD	Ohmite
AE	Spectrol
AF	Sprague
AG	Erie Resistor Co.
AH	Good-All Mfg.
AI	General Instrument
AJ	Cambion
AK	Arco
AL	Centralab
AM	Plasticon
AN	P.R. Mallory Co.
AO	Delevan Mfg.
AP	Probescope Co., Inc.
AQ	Stancor
AR	Dialight Co.
AS	General Electric
AT	Thomas
AU	Semicon
AV	Sylvania
AW	Electronic Research Co.
AX	Bussman Mfg.
AY	JBT Mfg.
AZ	Motorola

Voltage and Resistance Chart

Controls set as follows:

DEVIATION: Maximum
CENTER FREQUENCY: 0
MARKER: ON
COARSE BAL.: Max.-Counterclockwise
FINE BAL.: Max.-Counterclockwise
VIDEO FILTER: OUT
SCALE MULTIPLIER: X10
SCALE: RMS
ATTENUATOR: X10

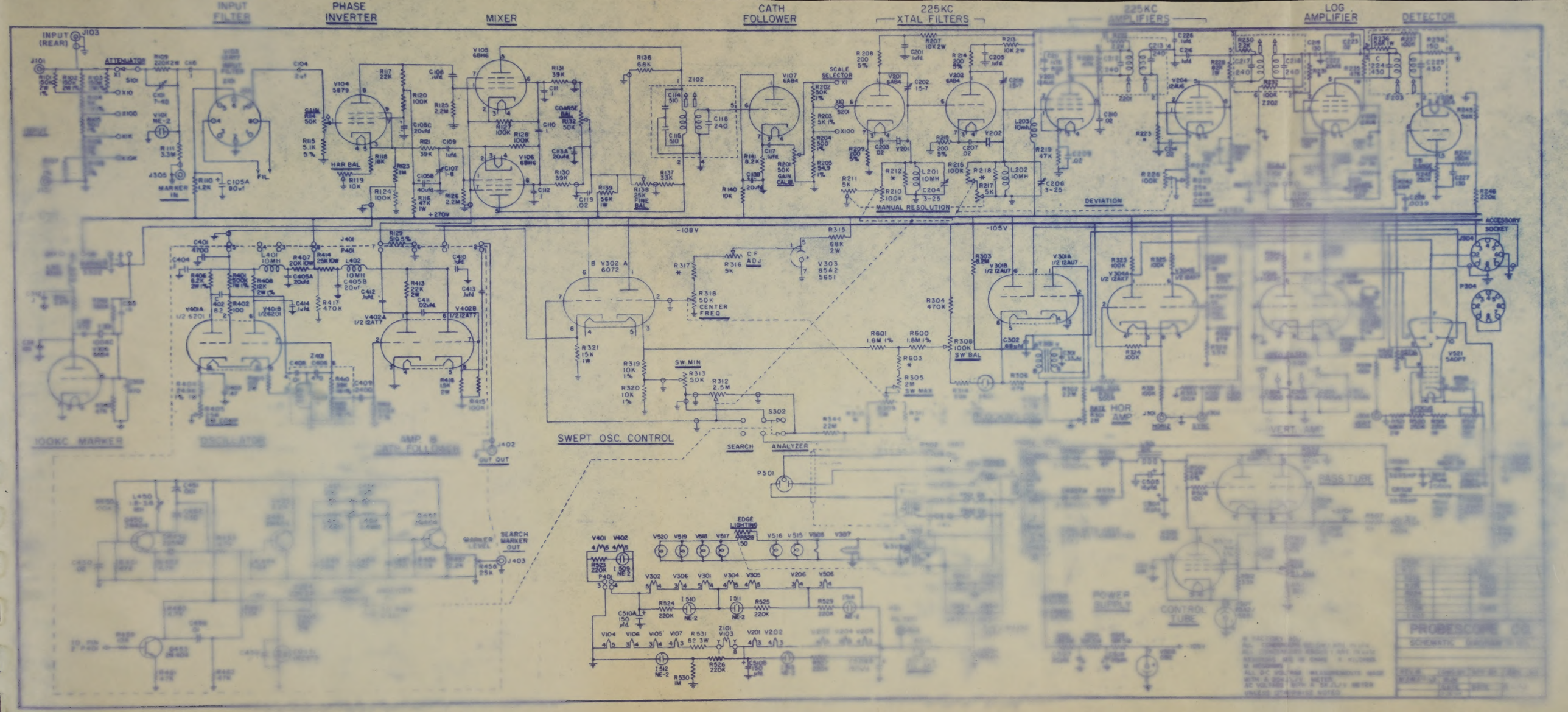
	1	2	3	4	5	6	7	8	9
V-505	210 5 M	410 350K	270 14K	210 5 M	410 350K	270 14K	3.2 VAC 0	3.2 VAC 0	
V-506	85 35K	85 80K	88 50	100 55	210 50M	90 80K	85 80K		
V-507	85 80K	0 0	NC NC	NC NC	NC NC	NC NC	NC NC		
V-508	0 0	-110 200K	NC NC	-110 200K	NC NC	NC NC	NC NC		
Z101	37 60	GR 0	NC NC	25 20	0 1.8M	270 16K	9.5 5K	50 53	
V-104	0 50K	NC NC	11 20K	0 0	6.5 5	NC NC	235 120K	240 60K	11 20K
V-105	0 2M	1.35 500	6.4 5	12 10	94 60K	80 40K	1.35 500		
V-106	0 2M	1.35 450	12 10	19 15	94 60K	62 50K	1.35 450		

	1	2	3	4	5	6	7	8	9
V-107	270 25K	NC NC	25 18	18 14	NC NC	0 10	5.2U 8K		
V-201	215 25K	NC NC	56 55	50 55	NC NC	0 5K	1.3 180		
V-202	210 25K	NC NC	60 58	55 58	NC NC	0 50	1.3 180		
V-203	0 55	6 4.5K	78 55	60 55	270 18K	250 65K	6 4.5K		
V-204	0 9	4 23K	80 55	90 55	110 18K	250 35K	6 25K		
V-205	0 80K	1.1 170	100 50	88 55	255 20K	85 25K	1.1 170		
V-206	Sig. Out 100K	NC NC	82 45	90 47	Sig. Out 100K	Sig. Out 100K	.5U 140		
V-301	45-65 7M	-10-20U 3M	0 0	55 35	43 28	270 16K	45-65 7M	75-95 40K	NC NC
V-302	270 15K	52 35K	56 18K	37 25	26 18	270 15K	12-14 1.4M	27-30 14K	NC NC
V-303	85 35K	NC NC	NC NC	NC NC	85 35K	NC NC	GR. 0		
V-304	195-225 100K	7.8-8.4 110K	14.3-14.7 270K	55 35	70 42	205-230 100K	19 16K	7.8-8.4 270K	NC NC
V-305	215-230 90K	-.4 900	1.5-1.8 300K	70 40	80 45	210-225 100K	0-(-1.7) 240K	1.5-1.8 300K	NC NC
V-306	9V 2M	NC	37 24	43 28	NC NC	-2.3 40K	GR. 0		

	1	2	3	4	5	6	7	8	9
V-401	145 50K	10-11 500K	23-36 28K	0 0	14 10	95 43K	-1-1.19 50K	0.5 90	NC NC
V402	50 50K	-.23--.25 470K	GR 0	14 9	26 18	120/37K	0 90K	4.4 1.3K	NC NC

The Following Measurements Are Made With A VTVM

	Emitter	Base	Collector
Q450	-2.7	2.5	-14.4
Q451	0.0	+0.03	-8.0
Q452	-7.7	-7.8	-14.5
Q453	-0.03	-0.07	-13.5


INPUT FILTER
PHASE INVERTER
MIXER
CATH FOLLOWER
225KC XTAL FILTERS
225KC AMPLIFIERS
LOG AMPLIFIER
DETECTOR
INPUT (REAR)
ATTENUATOR
MARKER IN
GAIN ADJ
HAR BAL
COARSE BAL
FINE BAL
SCALE SELECTOR
GAIN CALIB
MANUAL RESOLUTION
DEVIATION
ACCESSORY SOCKET
100KC MARKER
OSCILLATOR
AMP & CATH FOLLOWER
SWEPT OSC. CONTROL
SW MIN
SW MAX
SW BAL
CF ADJ
CENTER FREQ
SEARCH ANALYZER
EDGE LIGHTING
SEARCH MARKER OUT
HOR AMP
VERT AMP
POWER SUPPLY
CONTROL TUBE
+270V
-108V
-105V